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Creators	Zulu, Sambo Lyson, Saad, Ali, Ajayi, Saheed and Unuigbe, Maria

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

3
4 **Abstract**

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

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

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

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

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41 **1. Introduction**

42 The magnitude of the construction industry ranks it as a prime sector at both local and
43 global levels. The industry employs over 2.4 million individuals and is valued at over
44 £100bn in the UK alone (Stiles et al., 2021), and over \$10 trillion globally (Büchner,
45 2019). Nevertheless, its fragmented market influences less innovation adoption and
46 more resistance to change (Ebekozién and Aigbavboa, 2021). Rather than embracing
47 innovations and exploiting their myriad advantages; instead, the construction industry
48 is reflecting a slow pace in this direction. While other industries excel due to digital
49 transformation (Zhang, 2021), the construction industry undermines wider digital
50 adoption (Opoku et al., 2021). The pace at which the industry is transforming towards
51 digitalisation is counterproductive and summons an overarching understanding of the
52 pressure points behind the slow uptake (Bademosi and Issa, 2021). Hence, there is a
53 need to reveal the routes where a plausible and compelling digital transformation may
54 support the industry's ability to address its modern challenges.

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

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

68 Generally, previous research efforts in construction have been tailored to focus on the
69 barriers of digitalisation particularly related to cost considerations, the challenging
70 learning curve, and the lack of awareness and knowledge. However, an exploration of
71 the influence of these barriers and their critical role in determining the factors that can
72 facilitate digitalisation in construction remains an understudied and timely topic.
73 Through this exploration, the study aims to guide construction organisations to the
74 determinants that can create the circumstances for digitalisation to effectively flourish,
75 overcoming the barriers and fostering a digitally embracing work culture in the UK
76 construction industry.**2. Literature review**

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

91 Information Systems (Shafiq and Afzal, 2020), Drones (Onososen et al., 2023), and
92 3D Printing (Agustí-Juan and Habert, 2017).

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

107 Despite the benefits of digitalisation in general, the adoption rate among
108 construction organisations could be faster (Ernstsen et al., 2021). Limited studies
109 highlight how an effective digital transformation could be achieved. Theoretically, it
110 has been argued that to enhance an innovation's uptake among a specific social
111 system, benefits and values alone may not drive an innovation-adoption (Rogers,
112 2003). Although benefits may shape a drive, determinants beyond what is perceived
113 as technical and innovation-oriented may aid a digital transformation from within an
114 organisation (Zulu and Khosrowshahi, 2021). Generally, scholars echo the
115 complications and ambiguities behind driving innovations in the construction context

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

123 Scholars realise the understudied nature of digitalisation in the construction
124 context, calling for comparable research. For instance, Prebanić and Vukomanović
125 (2021) report, through a recent systematic review, the discreetly digitalised nature of
126 the construction industry, calling research to explain and understand such social
127 phenomenon. Moreover, Weber-Lewerenz (2021) emphasise the need to facilitate
128 studies investigating the acceleration of digital transformation in construction.
129 Similarly, Zulu and Khosrowshahi (2021) acknowledge the need for research to
130 explore the success factors that would articulate the current digital adoption rates and
131 the role of leaders in doing so. A review of literature, therefore, proves a lack of similar
132 research, shedding light on a research gap concerning the factors that determine an
133 effective digital transformation (Zulu et al., 2023). Despite the immense potential for
134 digitalisation to offer key opportunities long due by the industry, the underlying
135 indicators that can determine a transformation are yet understudied, presenting an
136 opportunity for an exploration to address such a knowledge gap. Through a qualitative
137 investigation, this paper seeks to pursue an understudied viewpoint to reveal whether
138 patterns of data could mirror employees' consensus that particular variables can act
139 as determinants of wider digital uptake among construction firms.

140 **3. Research method**

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

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

166 Convenience sampling was utilised to collect data based on the convenient
167 availability of participants in terms of time, location, access, and willingness to get
168 involved (Whitehead and Lopez, 2016). Conditioned to being construction
169 professionals, participants were encouraged to identify what determines an effective
170 digital transformation in their organisations without any constraints on broader
171 illustrations and discussions. Overall, participants from 38 construction organisations
172 agreed to participate in this qualitative study, generously providing their perceptions
173 by responding to a diverse set of questions. Individuals representing construction
174 organisations ranged from local contractors to large international companies involved
175 in vast construction and infrastructure activities and developments. All of the
176 participants received the same questionnaire, and questions sought information on the
177 organisational characteristics, level of digital uptake, digital readiness, general and
178 specific perceptions, barriers, and leadership roles. These questions were designed
179 with the intention to provoke as much information as possible to satisfy the objectives
180 of this exploration. The number of participants may be perceived as small; however,
181 data shaped a detailed perspective in line with this study's aim, deeming it sufficient
182 to identify their experiences of a phenomenon (Starks and Trinidad, 2007). This is
183 because qualitative methods are not influenced by sample size but rather by data
184 saturation (O'Reilly and Parker, 2013). Overall, participants are classified as 21%
185 entry-level employees, 61% construction professionals, 5% middle managers, and
186 13% first-level managers.

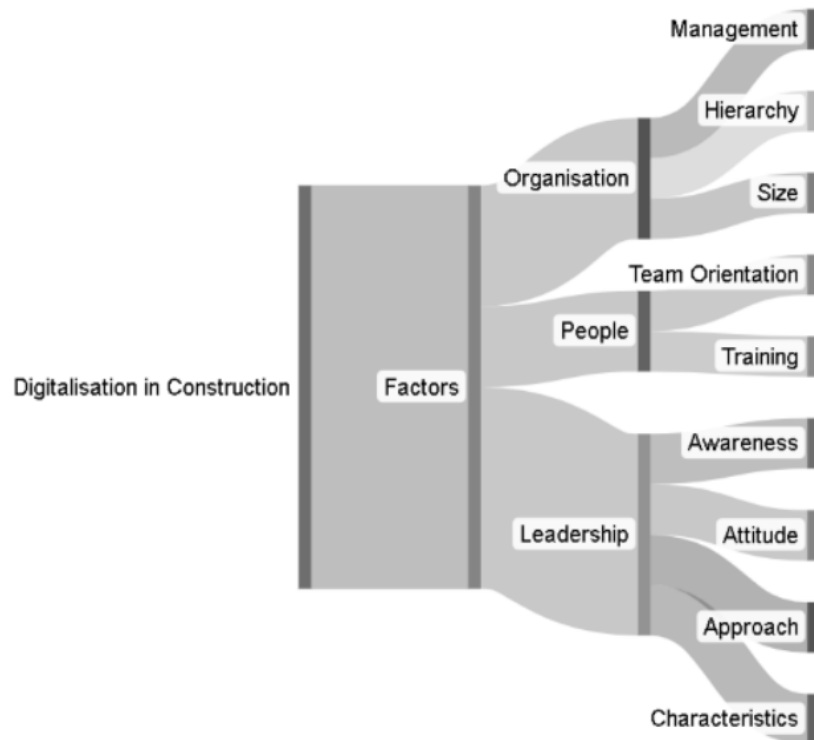
187 Due to the overwhelming amount of data, the analysis of the qualitative inputs
188 includes condensation (Rabiee, 2004). Subsequently, data was analysed thematically
189 and inductively. This means that recurring themes of importance have been identified
190 based on data patterns (Boyd and Ashley, 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).

205



206

207 **Figure 1:** Factor clustering determining digital transformation in construction organisations

208 *4.1. Organisational management*

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

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

236 4.2. Organisation's hierarchy

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

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

255 *4.3. Organisation's size*

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

263 *4.4. Team orientation*

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

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

283 *4.5. Knowledge and training*

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

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

296 4.6. Leadership Awareness

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

309 4.7. Leadership Attitude

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

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

322 *4.8. Leadership Approach*

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

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

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

352 4.9. Leader characteristics

353 Age is emerging as a determinant within leaders' characteristics, highlighting that the
354 demographic nature of an organisation, particularly leaders, can influence digital
355 adoption; "*the company has a young demographic, so everyone is computer literate*
356 *and recognises the opportunities digital applications offer to the organisation*" (P13).
357 As a result, a positive influence emerges between age and innovation, which is
358 identified as a particular driver of innovation in family firms; "*I work for a family*
359 *business, and therefore it would only be the younger generations that would be willing*
360 *to learn the new programmes*" (P28). This as well raises arguments on the influence
361 of age driving positive output. Overall, participants reflect on the impact of age,
362 confirming the above discussions and sustaining a critical factor within leaders'
363 characteristics influencing broader digital change; "*being of the older generation and*
364 *does not understand how the technology work*" (P17), "*the age of people in leadership*
365 *positions*" (P27), "*we are fortunate to have a lot of younger people*" (P36). Participant
366 28 also notes that due to this generation being in their positions, the sequence of

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

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

389 **5. Discussion**

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

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

395 Findings underline the influence of the characteristics of higher management
396 on the influential leadership role within an organisation through the use of the term 'old
397 school' to reflect a mindset inhibiting change; such a character carries a conventional
398 stance and may not be well equipped to embrace innovation or change (Broshi-Chen
399 and Mansfeld, 2021). Results are consistent with previous literature revealing that
400 directors can facilitate change (Network, 2015). More research is needed to highlight
401 the influence of roles on digital adoption. Nevertheless, findings suggest that education
402 is critical among higher management roles, an aspect that can facilitate more informed
403 decisions and urge employees towards the innovation's direction (Psychogios et al.,
404 2009).

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

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

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

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

435 Similarly, team orientation is linked to successful outcomes in a firm's
436 performance compared to those not fostering such collaboration (Kilcullen et al.,
437 2022). Participants have highlighted the influence of employees on their leaders,
438 where leaders' openness to sustain a team-oriented mindset would be by acquiring a
439 more excellent abstraction capability (Midgley and Dowling, 1978). Leaders' practices
440 and behaviour influence the team's goals and priorities (Alexander and Van

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

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

452 Participants reflecting a positive awareness among their leaders tend to be from
453 organisations that gather information on digital environments (Peillon and Dubruc,
454 2019). Leadership awareness is a critical determinant of change (Auvinen et al., 2019),
455 driven by the leadership style that facilitates an effective transformation (Naqshbandi
456 and Jasimuddin, 2018). Such a mindset is driven by cost (Müller et al., 2018) and
457 awareness (Peillon and Dubruc, 2019). In contrast, an unclear strategy to implement
458 and adopt digital transformation limits the exploitation of digital advantages (Hanelt et
459 al., 2021). A clear strategy aids the organisation in seizing critical opportunities and
460 maximising its digital experience (Singh et al., 2020). Findings suggest that a penalty
461 approach is practical only when associated with a bonus approach (Aben et al., 2021).
462 Therefore, it is how leaders orchestrate and frame their approaches to align with
463 change, not vice versa, a philosophy described as critical when shaping an effective
464 digital transformation strategy (Kim and Kim, 2022).

465 Findings suggest the existence of multiple characteristics that can differentiate
466 leaders from firms with higher digital uptake compared to those lagging. Literature has
467 previously identified the relationship between age and innovation (Santoro et al.,
468 2021). Age influences leaders themselves, as older employees tend to be less driven
469 towards innovation (Li et al., 2021). Moreover, leaders from family organisations tend
470 to excel in fostering change, which aligns with Block et al. (2022) argument that family
471 firms are "*doing more for less*" p.13. Additionally, Haider et al. (2021) infer that the
472 innovativeness of leaders can be measured through their ability to accept and drive
473 new ideas and concepts, hence, generally being open to innovation. This can be seen
474 as trivial, as openness to innovation is reasonably a characteristic of successful digital
475 leaders (S. M. Ferdous Azam, Normy Rafida, Mohd. Mousa Mustafa Odeh, 2021);
476 nevertheless, it stands as another determinant in this paper. Finally, the availability of
477 software does not necessarily mean the existence of sufficient reasoning for the
478 change. There is a critical divergence between organisations offering the means of
479 innovation and those driving innovation (Birasnav et al., 2022). Tentatively, late digital-
480 adopting organisations need a sense of willingness and urgency to digitally transform
481 (Fredberg and Pregmark, 2022). Such a determinant is described to be driven and not
482 simply achieved by the availability of digital technologies but by the fundamental
483 willingness to change.

484 Therefore, this study responds to the recent calls made by Zulu and
485 Khosrowshahi (2021), Prebanić and Vukomanović (2021), Baptista et al. (2020) and
486 Weber-Lewerenz (2021) on the necessity for research to study digitalisation across
487 the construction sector, aligning with leadership theories (Müller-abdelrazeq, 2016),
488 diffusion of innovation (Rogers, 2003), and organisational culture (Martínez-Caro et
489 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
<i>What determines an effective digital transformation among construction firms?</i>		
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

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

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

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

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

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

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