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UNRAVELLING THE ROLE OF DIGITAL PARTNERING IN SUCCESSFUL CONSTRUCTION DIGITALISATION – AN EMPIRICAL INVESTIGATION

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Abstract. This study explores the concept of digital partnering among construction organisations, focusing on the essential factors that contribute to successful partnerships and their impact on achieving digital transformation. To gather quantitative data, a survey was conducted with construction professionals engaged in projects throughout South Africa. The data analysis employed a comprehensive six-step methodology, including mean item scoring, Kruskal-Wallis H-Test, exploratory factor analysis (EFA), and multiple linear regression (MLR). The findings from the EFA indicated that the effectiveness of digital partnering hinges on three critical elements: a supportive partnering environment, trust and mutual understanding, and management support. The MLR analysis further validated these factors as crucial for attaining digitally transformed construction organisations. Given the competitive and often adversarial nature of the construction industry in developing countries like South Africa, the study recommends that organisations pursue collaborative partnerships both within and outside the industry to facilitate digital transformation. This can be achieved by fostering an environment that nurtures trust, understanding, and strong management support for developing digital capabilities through collaboration. The study offers empirical insights into the key factors necessary for successful digital partnering, an area that has been largely overlooked in discussions surrounding construction digitalisation.

Keywords: *Construction industry, digital partnering, digital transformation, digitalisation, Fourth Industrial Revolution.*

INTRODUCTION

The Fourth Industrial Revolution is rapidly transforming how people live and work through technologies that enable fast connectivity between people and machines and generate massive amounts of data, leading to increased access to knowledge (Schwab, 2016). This industrial revolution is envisioned to create a global business network by unifying smart machines, robust storage systems, and

production units as cyber-physical systems. Digitalisation, a critical driver of this revolution, is improving the effectiveness and efficiency of production and business operations across industries. Digitalisation involves using digital technologies instead of manual processes to carry out daily activities (Kalavendi, 2017; Ochs & Riemann, 2018).

Past studies have highlighted the benefits of digitising construction practices (Aboushady & Elbarkouky, 2015; Berger, 2016; Delgado et al., 2019; Oke et al., 2018) and the slow adoption of beneficial emerging digital technologies, particularly in the construction industry of developing countries (Aghimien et al., 2018; Hampson et al., 2014; Handler, 2017; Pärn & Edwards, 2019). Research from other industries provides insights into factors enabling organisational digital transformation, such as considering critical elements like leadership, customer experience, information, operating model, and workforce (Whalen, 2015; Gill et al., 2016; Valdez-de-Leon, 2016; Newman, 2017; Klötzer & Pflaum, 2017; Dyk & Schutte, 2012). However, partnering with other organisations with complementary resources to improve digital capabilities has not received adequate attention.

While the existing studies provide guidelines for construction organisations to enable digital transformation, partnering with organisations with complementary digital capabilities is necessary. The Economist Intelligence Unit (EIU, 2015) noted that organisations need assistance from others with a shared digital vision to thrive in the competitive digital environment. This is especially important for construction firms struggling to fully understand digitalisation and how to apply it, associating with organisations with complementary digital capabilities. This concept in the context of this study is known as digital partnering (DP), and it is vital for the success of construction firms' digital transformation journeys. However, there is a paucity of empirical research on DP in the construction industry. This paper makes a case for adopting DP in the quest for construction digitalisation. It assesses the factors needed for successful DP in construction and how these factors influence digitalisation, with the aim of informing organisational policies for digital transformation. Subsequent parts of the paper cover the theoretical background, the methodology adopted, the major findings, and the conclusions drawn from the findings.

1. DIGITAL PARTNERING IN CONSTRUCTION

The Dynamic Capability Theory (DCT) proposed by Teece and Pisano (1994) provides a useful framework for construction organisations seeking to undergo digital transformation in the dynamic digital landscape. Construction activities are inherently complex and ever-changing, while the digital world is also in a constant state of flux. Therefore, construction organisations need capabilities that enable them to adapt quickly and make reasonable changes to withstand the rapid changes in their environment. Teece et al. (1997) defined dynamic capabilities as "the firm's ability to integrate, build and reconfigure internal and external competencies to address rapidly changing environments". Past studies have identified three critical capabilities required for organisations to enhance their business performance. These are sensing, seizing, and reconfiguration capabilities (Teece, 2007; Zollo & Winter,

2002). However, these capabilities must be rooted in the organisation's managerial and operational processes, which are shaped by the organisation's asset position and evolutionary path (Teece et al., 1997). The organisational and managerial processes involve coordination, learning, and reconfiguration, leading to transformation. Specifically, the learning process is driven by various internal and external factors, including collaborations and partnerships with other organisations. Given the slow pace of digitalisation in construction, organisations need to engage in partnering with other organisations within and outside the industry to improve their organisational learning and gain a better competitive advantage.

To understand the concept of digital partnering, it is necessary to explore the general concept of partnering, which has become popular in the construction industry. In the literature, the collaboration between two or more organisations to achieve a common goal has been described using various terms, such as network, partnership, partnering, integration, and strategic alliance (Cheng et al., 2000). However, there is a distinct difference between partnership and partnering, wherein partnership refers to a legal entity or business structure, while partnering is a way of conducting business. In partnering, two or more entities make a long-term commitment to fulfilling specific objectives by leveraging each other's resources (Construction Industry Institute, 1991). Nunez et al. (2018) stated that partnering is a management tool used to ensure that all parties to a contract are committed to the set goals. Building on the general concept of partnering, digital partnering (DP) is conceptualised as a commitment between two or more organisations to achieve digital transformation by maximising the effectiveness of each participant's resources. In contrast with the general concept of partnering in construction, where the focus is on successful project completion, DP aims to achieve the digitalisation of organisations using shared resources. The importance of this process is evident in the submission of Vollmer and Egor (2004), who stated that partnering with other organisations is beneficial for businesses seeking to grow in unfamiliar markets.

For the DP process to be successful, certain success factors need to be in place. While the selection of these success factors can be controversial as they are influenced by local culture and practices (Doğan et al., 2015), some factors exist within the body of literature that can be used as a guide. Since the concept of DP has not been explicitly stated within the literature as a means of digital transformation for construction organisations, it is necessary to draw from the generic partnering process to determine the factors for successful DP. This study draws from Nystrom's (2005) partnering flower theory and other knowledge extracted from existing studies. While the literature provides a wide range of success factors for partnering, a critical review revealed significant similarities and repetition. Therefore, discussing and adopting the major recurring factors is necessary.

Nystrom's (2005) partnering flower theory describes the success of a partnering process as a flower with two central factors (trust and mutual understanding) and other factors surrounding them as the petals. For the success of any partnering process, trust and mutual understanding towards the attainment of a common goal are essential. Additional factors, such as dispute resolution, economic incentive, facilitator, openness, continuous meetings, partner selection, and relationship-

building activities, can then be incorporated based on the project characteristics. Critically evaluating these factors, they are applicable to DP as trust and mutual understanding of a common goal and are essential for construction organisations seeking digital transformation. Due to the slow adoption of digitalisation in the construction industry, most organisations are unsure of how to begin this digital transformation journey. Partnering with organisations they can trust to guide them correctly is necessary. Trust fosters closeness among partners and helps in easier dispute resolution when issues occur (EIU, 2017). Past studies have also emphasised the importance of trust in any partnering agreement (Wøien et al., 2016). Similarly, organisations engaging in DP will want to ensure that they are working towards a common goal with their partners. Achieving a common goal can be a win-win process, where everyone gets what they desire from the partnering relationship (Kadefors, 2004). However, such a win-win scenario is often impractical, necessitating mutual understanding and some level of compromise between partners (Nystrom, 2005). Choosing a partner is also crucial, as most construction organisations are unfamiliar with the digitalisation process. Selecting the right partner with complementary resources is essential for the success of the DP process, as the construction industry faces a scarcity of resources such as technology, knowledge, information, and personnel (Chan et al., 2004). Additionally, the decision to adopt partnering as a strategy for digital transformation is largely dependent on the organisation's top management. The top management is responsible for formulating business strategies and directions, so the decision to partner or not as a strategy for digital transformation lies with them (Cheng et al., 2000; EIU, 2017). Other factors include an effective conflict management process (Chan et al., 2004; Nystrom, 2005), an open communication system among partners (Cheng et al., 2000; Cheng & Li, 2002; Nystrom, 2005; Tang et al., 2009), continuous and structured meetings and training, intention to create a long-term relationship, the use of a facilitator to coordinate the process, and the provision of incentives for the partnering parties (Barlow, 2000; Naoum, 2003; Nystrom, 2005).

2. RESEARCH METHODOLOGY

A post-positivism philosophical stance using a survey approach was adopted since the study explored the significance of existing partnering factors to the success of DP in construction. The instrument for data collection was a questionnaire, which was adopted due to its ability to cover a broader range of respondents within a short period and, at the same time, allow for quantifiability and objectiveness in the research (Tan, 2011). The questionnaire was designed in sections, with the first section seeking answers to some questions on the background of the respondents. The second section explored the factors necessary for successful DP. To achieve this, a clear definition of the concept of DP was given in the questionnaire to create a unified understanding of the concept under review and to harness a valid result. Furthermore, ten success factors earlier identified in the literature were assessed in relation to DP. The last section assessed the influence of the success factors of DP

on the digital transformation of construction organisations. The questions in the second and third sections were measured using a 5-point scale.

The population for the study was construction professionals with at least five years of working experience with a construction organisation in South Africa. These sets of respondents were selected on the premise that they form the core of the construction process, and their opinion was sought based on the applicability of the questions to their respective organisations. Based on the database of the respective professional bodies derived from their annual reports, the total population for the study was 40 188 professionals. This figure was further reduced to 546 using Cochran's sample size equation at a 90 % confidence level and a ±7 % margin of error with a 0.5 estimated proportion of the population. Out of the envisaged sample of 546, a total of 222 professionals (representing a 40.5 % response rate) participated in the survey. The data analyses were done using the analysis framework in Fig. 1.

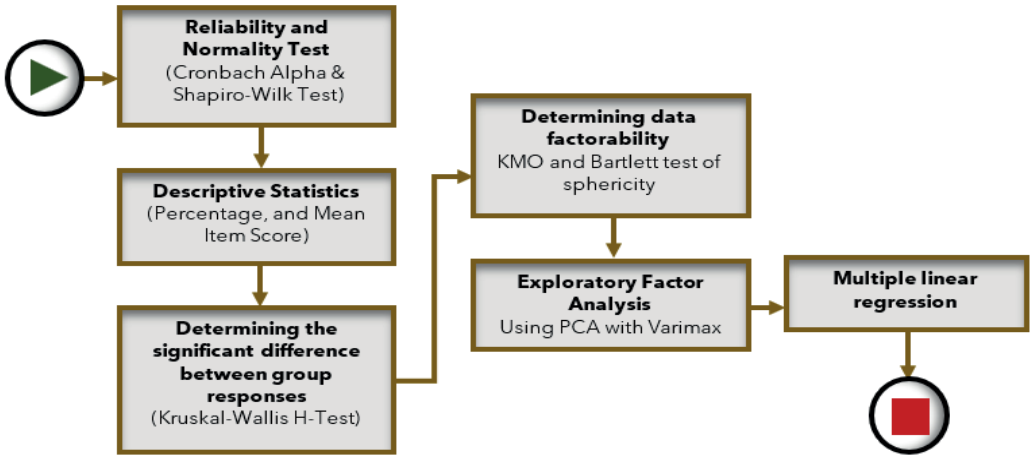

Fig. 1. A framework for data analysis.

First, the reliability of the questionnaire was tested using the Cronbach alpha (α) test. The closer the α value is to one, the more reliable the instrument used (George & Mallery, 2000). Shapiro–Wilk test (S–W) was also used to ascertain the normality of the distribution of the data gathered. Ghasemi and Zahediasl (2012) earlier suggested the use of S–W for data gathered from a sample of below 2000, as in the case of this current study. Percentage was used in analysing the background information of the respondents, while the mean item score ($\overline{X}$) was used to rank the assessed factors. Further to this, the significant difference in the view of the different groups of respondents was tested using Kruskal–Wallis H-test (K–W). This is a non-parametric alternative to the analysis of variance and is suitable for determining the difference in the view of three or more groups. K–W was adopted based on the result from the normality test, which revealed that the data gathered were non-parametric in nature. Although the assessed success factors were manageable (ten in number), the possibility of some factors having similar underlying effects existed. Based on this assumption, exploratory factor analysis

(EFA) was conducted to further group the identified factors into more manageable subscales. To conduct this test, the factorability of the data was first tested using Kaiser–Meyer–Olkin (KMO) and Bartlett's test of sphericity. The threshold for KMO was set at 0.6 based on past set thresholds (Field, 2005; Tabachnick & Fidell, 2007), while the Bartlett test is expected to be significant at less than 0.05 (Bartlett, 1954; Tabachnick & Fidell, 2007). The sample size of the study was also considered adequate as it is above the 150 minimum samples recommended by Tabachnick and Fidell (2007). Lastly, multiple linear regression was used to ascertain the influence of the extracted grouped factors from EFA on the digital transformation of construction organisations. This was necessary, as EFA only showed the relationship of these DP success factors with one another and not with the digital transformation of construction organisations. The premise of adopting this test was only to see if these extracted factors would help achieve construction digitalisation or not.

3. FINDINGS AND DISCUSSION

3.1. Background Information of Respondents

The background information of the respondents in Table 1 revealed that response was obtained from professionals in eight out of the nine provinces in South Africa, with more responses obtained from Gauteng and fewer responses from North-West, KwaZulu-Natal and Eastern Cape.

Table 1. Background Information of Respondents

Category	Classification	Frequency	Percentage
Profession	Architect	34	15.3
	Engineer	59	26.6
	Construction manager	32	14.4
	Construction project manager	26	11.7
	Quantity surveyors	71	32.0
	Total	222	100.0
Years of experience	1–5 years	70	31.5
	6–10 years	67	30.2
	11–15 years	53	23.9
	16–20 years	18	8.1
	Above 20 years	14	6.3
	Total	222	100.0
	Average	9.2 years	
Highest academic qualification	Diploma	38	17.1
	Bachelor's/Honours Degree	115	51.8
	Master's degree	61	27.5
	Doctorate	8	3.6
	Total	222	100
Type of organisation	Government	49	22.1
	Consultancy	65	29.3
	Contracting	108	48.6
	Total	222	100.0

No response was obtained from the Western Cape. More quantity surveyors (32 %) and engineers (26.6 %) participated in the survey. The majority of these professionals have bachelor's degrees (51.8 %). This is followed by a master's degree (27.5 %), diploma (17.1 %) and doctorate (3.6 %). Most of the respondents work in contracting firms. On average, all the respondents have 9.2 years of working experience within the South African construction industry. The background information reveals that the respondents for the study have a considerable level of academic qualification and years of experience to understand the questions of the research. Therefore, the answers given can be relied upon as they were based on the experience gathered over the long years of working in the industry.

3.2. Critical Factors for Successful Digital Partnering

In determining the factors for successful DP, respondents were presented with ten factors to rate using a 5-point Likert scale, with five being very high significance and one being very low significance. The result in Table 2 revealed an α value of 0.852, which is above the 0.7 cut-off set for the internal reliability of the questions in this section. Since this α value is closer to one, it implies that the questionnaire used was reliable.

Table 2. Mean Rank and K–W Result of the Success Factors for Digital Partnering

Success factors	Overall		S–W		K–W	
	$\bar{X}$	Rk	Stats.	*p*-value	χ^2	*p*-value
Top-management support	4.93	1	0.149	0.000	1.361	0.506
Trust in digital partners	4.84	2	0.264	0.000	1.640	0.441
Digital partner selection	4.74	3	0.394	0.000	6.154	0.046**
Common goal in the partnering process	4.72	4	0.411	0.000	9.962	0.007**
Open communication system	4.60	5	0.488	0.000	0.840	0.657
Digital partnering coordination	4.59	6	0.497	0.000	7.557	0.023**
Incentives in digital partnering process	4.56	7	0.525	0.000	4.349	0.114
Long-term commitment to digital partnering	4.54	8	0.531	0.000	0.670	0.715
Structured digital workshop and training	4.45	9	0.576	0.000	0.142	0.932
Conflict resolution in digital partnering	4.41	10	0.596	0.000	1.834	0.400
Cronbach α	0.852					
χ^2	4.039					
Df	2					
Assymp. Sig	0.133					

Note: $\bar{X}$ – mean item score; Rk – rank; S–W – Shapiro–Wilk test for normality; K–W – Kruskal–; Wallis H-test, χ^2 – Chi-square; *Df* – Degree of freedom; ** significant at $p < 0.05$.

Also, the normality test (S–W) revealed that the data was not normally distributed as a significant *p*-value of 0.000 was derived for all assessed factors. This implies that only statistical analysis that does not need data distribution to be normal (parametric) can be used for further analysis. The table further reveals that all the assessed factors had an overall $\overline{X}$ of well above the average of 3.0. This indicates that these factors have high significance to the success of the DP process. On the overall, the top three significant factors are top management support ($\overline{X} = 4.93$), trust in digital partners ($\overline{X} = 4.84$), and digital partner selection ($\overline{X} = 4.74$). K–W test conducted revealed that while no significant difference exists in the view of the three different groups of respondents for most of the factors, there is a statistically significant difference in their view of digital partner selection (*p*-value = 0.046), common goal in the partnering process (*p*-value = 0.007), and digital partnering coordination (*p*-value = 0.023). However, the disparity in the view of these three variables does not affect the way the respondents view the general factors, as the overall K–W test revealed χ^2 value of 4.039 and a *p*-value of 0.133, which is higher than the 0.05 threshold for a significant difference to occur.

Table 3 revealed a KMO value of 0.801, which is above the 0.6 threshold required for EFA. Also, the Bartlett test was significant at a χ^2 value of 897.53 and a significant *p*-value of 0.000. Following these preliminary results, EFA was conducted using principal component analysis (PCA) with varimax rotation. The analysis revealed that all the factors assessed had considerably high communalities of above 0.5, as seen in Table 3. Furthermore, PCA gave three extractions with an eigenvalue of above 1. The combination of these three extractions accounts for 67.7 % of the total cumulative variance. This is above the 50 % threshold for an acceptable extraction, as observed by Stern (2010).

The first group of success factors extracted accounts for 43.4 % of the total variance explained. Five variables were revealed for this group: structured digital workshop and training, conflict resolution in DP, open communication system, incentives in the partnering process, and long-term commitment. Based on the underlying similarity in these factors, the component was named conducive environment. The second group of success factors extracted accounts for 14.1 % of the total variance explained and has variables such as trust in digital partners, common goal in the partnering process, digital partnering coordination, and digital partner selection. This component was named trust and mutual understanding. The last group of success factors accounts for 10.2 % of the total variance explained and has only top management support loading on it. Thus, this component was named management support. Therefore, if construction organisations are to attain digital transformation through DP, consideration must be given to the creation of a conducive partnering environment where trust and mutual understanding exist, and management within these organisations must be willing to champion the course.

Table 3. Extracted Components

Factors	Component			Communalities	
	1	2	3	Initial	Extract.
Structured digital workshop and training	0.833			1.000	0.734
Conflict resolution in digital partnering	0.819			1.000	0.775
Open communication system	0.757			1.000	0.687
Incentives in the digital partnering process	0.710			1.000	0.657
Long-term commitment to digital partnering	0.610			1.000	0.544
Trust in digital partners		0.873		1.000	0.815
A common goal in the digital partnering process		0.734		1.000	0.672
Digital partnering coordination		0.548		1.000	0.639
Digital partner selection		0.512		1.000	0.526
Top-management support			0.848	1.000	0.724
Kaiser–Meyer–Olkin measure of sampling adequacy		0.801			
Bartlett's test of sphericity	Approx. χ^2	897.53			
	Df	45			
	p-value	0.000			

Note: Extraction method: principal component analysis. Rotation Method: varimax with Kaiser normalisation.

3.3. Enabling Role of Digital Partnering in Driving Successful Construction Digitalisation

Having understood the latent factors needed for a successful DP, it was essential to ascertain the impact of this successful DP process on the attainment of digitally transformed construction organisations. Based on this notion, construction experts were asked to rate the extent to which the assessed DP success factors will lead to the attainment of digitally transformed organisations on a 5-point scale, with five being a very large extent and one being no extent at all. The result gave an overall $\overline{X}$ of 4.41, which implies that these DP factors will, to a large extent, assist in the attainment of digitalisation. However, to ascertain the relationship between these extracted DP success factors and the digital transformation of construction organisations, multiple linear regression was conducted.

The result in Table 4 revealed 0.214 (21 %) for the multiple correlation coefficient (R^2), which is the measure of goodness-of-fit. Although most studies have advocated a high R^2 for a perfect fit, particularly in the field of pure science, Frost (2020) mentioned that a low R^2 does not imply an unfit or bad model. It was noted that most studies in the social sciences allow for the use of R^2 below 50 % due to the changes and difficulty in predicting human behaviour. Minitab (2013) further argued that if statistically significant predictors are derived, a logical

conclusion can be drawn from the analysis conducted. The result from the analysis shows that while the R^2 might be small, the three predictors (i.e., grouped factors) are statistically significant to the attainment of the dependent variable (i.e., construction digitalisation) as an overall t-value of 3.892 and a p-value of 0.000 was derived. This means that with a predictive power of 21 %, conducive environment (β = 0.122, *p*-value = 0.062), trust and mutual understanding (β = 0.203, *p*-value = 0.003), and management support (β = 0.282, *p*-value = 0.000) all have a significant influence on the digital transformation of construction organisations. Figure 2, therefore, shows the success factors needed for DP and the digitalisation of construction organisations.

Table 4. Summary of Regression Analysis

	Standardised Coefficients (β)	***t*-value**	***p*-value**	***R***	***R*²**	**Adjusted *R*²**	**Std. Error**
(Constant)		3.892	0.000	0.463a	0.214	0.204	0.640
Conducive environment	0.122	1.874	0.062				
Trust and mutual understanding	0.203	2.966	0.003				
Top management support	0.282	4.321	0.000				

Note: [a] Dependent variable: digitally transformed construction organisation;
[b] Predictors: (Constant), management support, conducive environment, trust & mutual understanding.

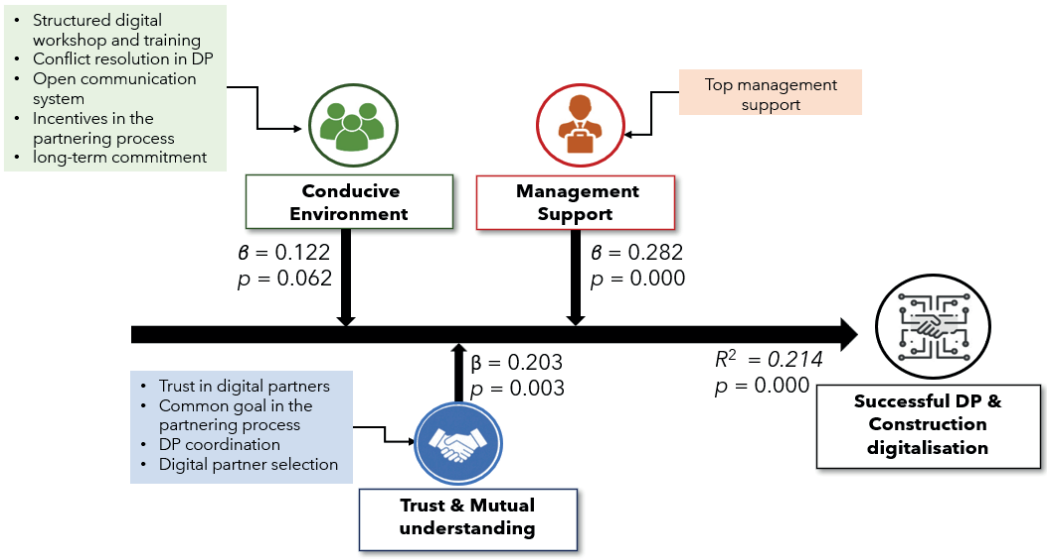

Fig. 2. Successful digital partnering.

3.4. Discussion and Implication of Findings

The findings of this study show that both the core factors of trust and mutual understanding, as well as the other surrounding factors in Nystrom's (2005) partnering flower theory, apply to DP. Furthermore, the study revealed three significant groups of factors related to the attainment of construction organisation digitalisation, as seen from the results of the regression analysis. Therefore, the practical implication of the findings lies in the submission that organisations seeking to go into a DP relationship to attain digital transformation must understand that for such a relationship to be successful, a conducive partnering environment is needed. This can be achieved through structured digital workshops and training, which is essential to construction organisations as most are inexperienced in the use of required digital technologies (Aghimien et al., 2018). In line with past studies, having an open communication system within the digital partnering relationship will help ensure trust among partners and allow early identification and solving of problems (Cheng & Li, 2002; Nystrom, 2005; Tang et al., 2009).

Similarly, having a healthy conflict resolution mechanism in place will ensure a conducive environment (Chan et al., 2004; Cook & Hancher, 1990; Nystrom, 2005). Furthermore, since the attainment of digitalisation is not a once-off process (Struková & Líška, 2012), there must be a clear intention to create a long-term commitment to the DP process. Organisations going into DP relationships must understand the need for a long-lasting relationship designed to ensure that the objectives of digital transformation are attained. Some form of incentive (financial or technical) can also serve as a motivation for these organisations to stay true to the DP relationship. There is also the need for trust and mutual understanding to attain a common goal. Nystrom (2005) showcased the importance of these factors to the success of any partnering process. In attaining digitalisation through DP, construction organisations must trust in their partners and the process. Carefully selecting the right partner with complementary resources can go a long way in building confidence and trust in the relationship. Believing in the digital competence of the partners, as well as their integrity to stay true to the partnering process, is germane to the success of DP. Furthermore, the role of top management in the success of any business strategy is essential, and the same applies to DP. The decision to partner with other organisations (within and outside the industry) in the quest for a digitally transformed business process solely depends on the decision of management (EIU, 2017). Thus, their support in going into DP and seeing the whole process through to attaining the set of objectives is essential.

CONCLUSIONS

This study assessed the factors needed for successful DP in construction and the influence of these factors on the digitalisation of construction organisations. Using a questionnaire survey, the study concludes that the success factors that are in existence in studies on general partnering in construction are applicable to the success of DP. These factors also have a significant relationship with the digital transformation of construction organisations. Therefore, organisations seeking to attain digital transformation will do well by undertaking this journey with other

organisations within or outside the construction industry through the DP process. For this DP process to be successful, they must ensure that an atmosphere conducive to partnering success is attained. This can be through a well-structured digital workshop and training, a healthy conflict resolution system, open communication, incentives, and an intention to create long-term commitment. Furthermore, consideration must be given to trust and mutual understanding in the partnering process through careful selection of the digital partners, trust in the digital partner and the process, having a common goal, and effective coordination. Subsequently, there must be support from management to help ensure a successful DP process.

The study contributes practically to the attainment of construction digitalisation as it showcases the need for construction organisations to partner with other organisations in the quest for digital transformation. The study further reveals the factors needed for the success of such a process. Small and medium organisations can benefit through the adoption of DP to increase their competitive edge and win projects which were beyond their reach as a result of their individual digital resource shortcomings. Also, regulatory bodies within the construction industry can equally benefit from the findings of this study as it gives a guideline for promoting effective service delivery through the digitalisation of the organisations they oversee. Furthermore, this study can be beneficial to construction organisations in developing countries, particularly in Africa, where the construction industry is like what is attainable in the current study area. Theoretically, the study gives a platform for researchers seeking to explore the different ways of ensuring the digitalisation of organisations. While this study attempts to fill in the gap in the literature in terms of the success factors needed for DP in construction digitalisation – an aspect that has not gained significant attention in the fourth industrial revolution discourse, care must be taken in generalising the findings of the study. Response from some of the provinces in the country was low when compared to other provinces. This creates some imbalance in the response distribution across the country. Therefore, further studies can be conducted within these provinces with a low response rate to get a clearer view of their situation. A similar study can also be conducted in other countries to compare the results found in this current study.

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