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# 1 INFORMATION CULTURE AS A VALUABLE ELEMENT OF 2 STRATEGIC INFORMATION MANAGEMENT

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17 *SUMMARY: This study proposes a strategy development framework for information management in a*  
18 *construction business. The framework covers the typical project lifecycle of a construction business which*  
19 *includes work winning and delivery. It incorporates a cultural analysis approach that covers the range of*  
20 *cultural manifestations expected in organisations. The approach also combines qualitative and quantitative*  
21 *research techniques. Application of the proposed framework for the development of information management*  
22 *strategy in a leading construction business showed that examining the information culture of the leadership and*  
23 *staff of the organisation is helpful in exposing the relevant informational issues. The case study also helped to*  
24 *validate that the proposed framework is a viable method for identifying and resolving informational issues*  
25 *inherent in construction organisations. Lastly, considering that the information management strategy developed*  
26 *in this study is for a typical construction business, other companies in the same domain will find the resource*  
27 *valuable.*

28 *KEYWORDS: information, culture, construction.*

29 *WHAT WAS KNOWN BEFORE:*

- 30 • *Previous studies in this area have focused on developing analysis frameworks, presenting assessments,*  
31 *and describing case studies for understanding the impact of culture on information communication*  
32 *technologies for performance improvement in construction.*
- 33 • *None of the studies has proposed and validated a strategy development framework for information*  
34 *management that construction businesses can adopt.*

35 *WHAT THIS PAPER CONTRIBUTES:*

- 36 • *This study proposes a strategy development framework for information management that covers the*  
37 *range of cultural manifestations expected in construction organisations.*
- 38 • *It provides a case study of strategic information management development in a construction business.*

## 39 **1. INTRODUCTION**

40 The delivery of the right information to the right people at the right time has significant implications for the  
41 success or failure of projects (Dzokoto, 2015). In construction operations, the complex relationships that exist  
42 between stakeholders inhibit effective identification of information requirements, which in turn hinders effective  
43 information creation, dissemination and use (Austin et al., 2002). Typical construction projects involve  
44 temporarily connected organisations working together. This unique cultural paradigm underpins some of the  
45 informational issues in the sector. It challenges the integration of knowledge within the construction process and  
46 can result in delays and disputes (Nasrun et al., 2014). Therefore, for the success of construction organisations  
47 and the projects they manage, it is critical to understand the culture surrounding the informational issues better.  
48 Previous Studies in this area have focused on developing analysis frameworks, presenting assessments, and  
49 describing case studies for understanding the impact of culture on information communication technologies for  
50 performance improvement in construction. However, none of these studies has proposed and validated a strategy  
51 development framework for information management that construction businesses can adopt. To bridge this gap,  
52 this study proposes a framework that helps to incorporate (i) the behaviour of information users, and (ii) the  
53 information management practices of a construction business in its development of an information strategy.

54 This paper is organised as follows. Section 2 describes the research method. Section 3 provides a review of  
55 literature on culture in general, information culture in the construction industry, and cultural analysis approaches  
56 applicable to this research. Section 4 details the conceptual framework of the proposed strategy development  
57 technique incorporating information culture. Section 5 describes a case study to demonstrate and validate the  
58 proposed strategy development framework, and Section 6 concludes this work.

## 59 **2. RESEARCH METHOD**

60 This research combines deductive and inductive approaches. The deductive element is focused on hypothesis  
61 development using literature review. The hypothesis generated is systematically tested to check if it holds in the  
62 context of this study. The inductive element involves carefully making observations and using the observations  
63 to create theories about a studied case. The case study data is collected through participant observation,  
64 interviews, record reviews, group discussions, questionnaire, and literature review.

65 Regarding participant observation, the first author worked in the studied organisation through the period of the  
66 study. This involved fitting in, gaining the trust of members of the organisation and, at the same time, remaining  
67 sufficiently detached to be able to carry out the observation.

68 The required interviews were carried out in person i.e., face-to-face where possible. Where the latter was not  
69 possible, video conferencing technologies – Skype (Microsoft, 2021a) and Microsoft Teams (Microsoft, 2021b) -  
70 were used. The researcher conducted the interviews in an unstructured way, letting the interviewees speak freely  
71 about the relevant issues. About 100 unstructured interviews, targeted at the company leadership and key process  
72 owners, took place over a period of one year.

73 Regarding record reviews, the controlled documents supporting data management in the studied organisation  
74 were reviewed. In respect of group discussions, over 50 meetings involving process owners and information  
75 users took place to reconcile the differences in the information management views within the organisation.  
76 Lastly, a questionnaire survey was used for sampling the vast number of people interacting with the studied  
77 organisation's information.

## 78 **3. LITERATURE REVIEW**

### 79 **3.1 Strategic Information Management**

80 Strategic management in business seeks opportunities to add new resources, explore new territories, reduce cost  
81 or eliminate inefficiencies for competitive advantage or sustainment (IIBA, 2015). Examples of strategic  
82 management goals can be: the addition of new customers; improvements in quality, reliability, flexibility and  
83 decision making; or simply the struggle to survive. Strategic information management, by extension, examines  
84 the nexus between information systems and business strategy in achieving business objectives (Gajendran et al.,  
85 2012). It applies information systems and data to get meaningful information useful for better business

86 performance. The benefit of strategic information management for businesses is usually in the form of savings in  
 87 cost, time and effort related to decision making (Stewart, Mohamed and Daet, 2002).

88 **3.2 Culture**

89 Culture is the characteristics of a group of people shaped by shared values, norms, practices, and artefacts  
 90 (Gajendran et al., 2012). These shared manifestations of culture guide the way a group thinks, feels and acts  
 91 regarding a subject. Cultural manifestations are important because they help in the perception of the culture of a  
 92 group. The higher the level of cultural manifestation, the better the perception (Van Marrewijk, 2007). The  
 93 cultural models by Hofstede (2001) and Rousseau (1990) identify key cultural manifestations. A review of those  
 94 models shows that four important manifestations are core and essential in deciphering the culture of a group.  
 95 These are described as follows:

- 96 • Values: these are deep manifestations of culture shaped by beliefs and underlying assumptions.  
 97 Values inform the strategies applied in achieving the goals of an organisation. They may be difficult  
 98 to detect or openly espoused. They are difficult to detect when they are unconsciously conceived or  
 99 based on taken-for-granted perceptions or beliefs. They are openly espoused when they are reflected  
 100 in the goals and strategies of an organisation (Gajendran et al., 2012).
- 101 • Norms: these are rules or socially accepted standards that define what is normal or to be expected in a  
 102 group. Norms give people a way to gauge what is ‘normal’ in a specific context and at a specific  
 103 time. Norms are derived from values but have a more direct influence on behaviour (Choo et al.,  
 104 2006).
- 105 • Practices: these are patterns of behaviour, which are themselves repeated patterns of action, within a  
 106 group. Practices within a group may exist in form of rituals (procedures) and celebrations (Schein,  
 107 2004).
- 108 • Artefacts: these are created to express information about culture. Examples of cultural artefacts  
 109 include symbols e.g., colours, rituals e.g., greeting style, and heroes e.g., role models (Schein, 2004).

110 **3.3 Information culture in the construction industry**

111 Svärd (2014) posits that information culture is a set of human activities undertaken towards information. It  
 112 relates to organisational values, norms and practices regarding the use, management, and control of information  
 113 (Choo et al., 2006). Ginman (1993) found that a highly developed information culture is positively associated  
 114 with good organisational practices and successful business performance; hence planning for information culture  
 115 is mission critical. In construction, culture underpins the way actors interact with one another and behave with  
 116 information (Dzokoto, 2015). Evaluation of literature on information culture in the construction industry reveals  
 117 that researchers in the domain focused on developing frameworks, presenting assessments, and describing case  
 118 studies for empirical understandings of the impact of culture on information communication technologies (ICTs)  
 119 to assist with performance improvement.

120 Table 1 summarises evaluated literature and their contributions. Gajendran and Brewer (2007, 2012) and  
 121 Dzokoto (2015) developed frameworks for assessment of information culture. Adriaanse and Voordijk (2005)  
 122 and Issa and Haddad (2008) contributed research on the challenges culture brings to the application ICTs in  
 123 construction. Anumba et al. (2006) and Gajendran and Brewer (2010, 2012) contributed case studies on the  
 124 subject. None of these studies proposed a strategy development framework that can help construction businesses  
 125 incorporate information culture in their information management strategies.

126 *Table 1: Academic literature on information culture in the construction industry*

S/N	Source	Summary	Contribution		
			Framework	Review	Case Study
1	Adriaanse & Voordijk, 2005	This research analysed culture as an obstacle to the effective use of ICT systems in construction projects		√	

2	Anumba et al., 2006	This research studied the impact of culture on the integration of new ICT (GIS) in the construction industry			√
3	Gajendran & Brewer, 2007	This research developed a cultural analysis framework for the integration of information technology in construction industry	√		
4	Issa & Haddad, 2008	This study assessed the impact of organisational culture and information technology on knowledge sharing in the construction industry		√	
5	Gajendran & Brewer, 2010	This study discussed the impact of culture on the extent of ICT integration within the context of a construction project			√
6	Brewer & Gajendran, 2012	This study described the development of a process for understanding the link between culture and the use of ICT in temporary project organisations	√		√
7	Gajendran & Brewer, 2012	This study discussed the impact of cultural environment on the adoption of ICT in construction project organisations			√
8	Dzokoto, 2015	This research investigated actors in construction organisations to test the similarity of their information seeking behaviour	√	√	

### 127 3.4 Culture assessment

128 The level of harmony or ambiguity of cultural manifestations defines the different cultural paradigms that exist  
129 (Gajendran et al., 2012). One school of thought sees culture either as a variable or a root metaphor (Smircich,  
130 1983). Culture as a variable provides a simplified and functional approach to understanding culture. From this  
131 perspective, culture has a causal relationship to organisational performance - implying that modification of the  
132 behaviour of members results in changes in organisational outcomes. Culture as a root metaphor opposes the  
133 view that organisational effectiveness can be attained through direct cultural manipulation as this fails to address  
134 the negative features of people's behaviour, such as resistance to change. Rather, it promotes expressiveness,  
135 ideation and symbolism.

136 Another school of thought sees culture from three perspectives: integration, differentiation and fragmentation  
137 (Martin, 2002). From the perspective of integration, culture is shared across the various levels of an organisation.  
138 For differentiation, unique cultures exist at group and individual levels, and shared culture does not exist across  
139 the organisation. From the perspective of fragmentation, there is lack of clarity in cultural manifestations and  
140 culture is unshared in the organisation.

141 Another school of thought examines culture from multiple orientations: technical, practical and emancipatory  
142 (Alvesson, 2002). The technical orientation focuses on identifying and manipulating cultural variables to achieve  
143 the intended culture outcomes. The practical orientation focuses on the removal of communication  
144 misunderstandings within organisational groups to foster cultural understanding. The emancipatory orientation  
145 focuses on shedding light on aspects of culture that are exploitative in order eliminate the challenges associated  
146 with them.

147 Gajendran et al. (2012) identified the alignment of the latter two schools of thought; combined them as  
148 integration-technical, differentiation-practical, and fragmentation-emancipation positions; and proposed the  
149 combinations for cultural analysis in project organisations.

- 150 • Cultural analysis with the integration-technical approach seeks to develop and extend shared cultures  
151 that are positive by focusing on ways to integrate them within organisations. This type of analysis  
152 generally focuses on coordination and monitoring of the diverse groups of participants, proposing  
153 systems to monitor the progress made towards the achievement of the stakeholders' goals. This

154 approach is useful for studies that focus on fragmentation within groups in order to promote aligned  
155 and improved project outcomes (Baiden, Price and Dainty, 2006).

- 156 • The differentiation-practical approach seeks to understand communications between different sub-  
157 cultures (Ankrah and Langford, 2005). This type of cultural analysis assists in improving  
158 understanding between sub-cultures and can lead to conflict mitigation and enhanced project  
159 collaboration. It does not take an optimistic view of culture as in the technical-integration approach,  
160 rather it involves observing and interpreting organisations through appreciation (Wilimoft, 1997).  
161 Also, it does not advocate that managers control the values of their subordinates to achieve effective  
162 behaviours (Alvesson, 2002). By acknowledging misunderstanding, this approach accepts ambiguity  
163 and tries to remove it through symbolic communication.
- 164 • The fragmentation-emancipation approach seeks to understand the subjective informal aspects of  
165 project organisations in developing a better understanding of culture. This approach has ambiguity as  
166 a permanent state with different interpretations, paradoxes and multiple value systems being  
167 welcome. Understanding the ambiguities is the objective of cultural analysis using this method (Chan  
168 and Raisanen, 2009).

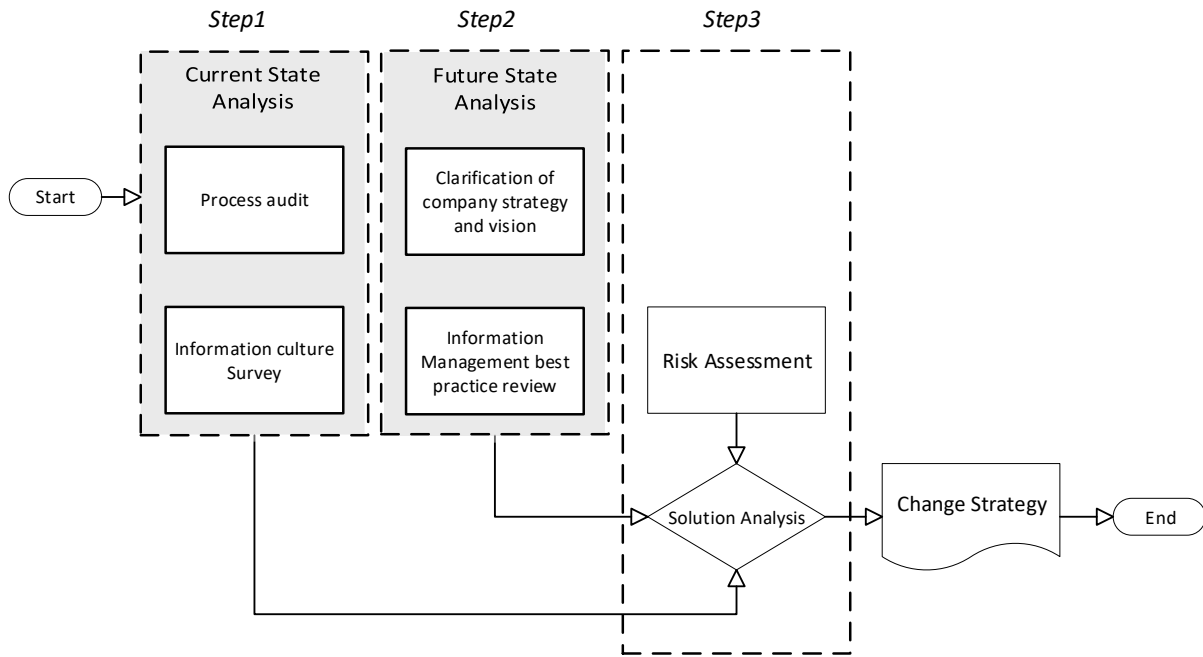
169 Gajendran et al. (2012) argue that a pragmatic way to analyse culture in organisations is to have the hybrid of the  
170 latter research methods. The integration-technical approach is of a functional paradigm because it involves  
171 manipulating variables. This can be achieved by quantitative analysis. The differentiation-practical and  
172 fragmentation-emancipation approaches can be categorised as non-functional because they do not involve  
173 quantitative data. They involve qualitative data obtained by observations and communication with the  
174 individuals in the studied group.

#### 175 **4. PROPOSED STRATEGY DEVELOPMENT FRAMEWORK**

176 The proposed framework in this research is based on inductive reasoning (Bryman and Bell, 2015), as theories  
177 are to be generated from the data collected using interpretivism (Saunders, Lewis and Thornhill, 2009),  
178 philosophical stance which emphasises the meaningful nature of people's participation in cultural life. The aim  
179 of data collection is to capture quality evidence that will enable an analysis that will support the development of  
180 the right strategy for the studied business. The strategy analysis technique developed by IIBA (2015) is adopted  
181 for the proposed framework. The framework includes steps that must be undertaken in order to establish needs of  
182 critical importance and identify the right solution plans to address them. The framework also follows the  
183 recommendation of Gajendran et al. (2012) which argues that a pragmatic way to analyse culture in  
184 organisations is to combine the various cultural analysis approaches. In this case, a survey is used to capture data  
185 for quantitative analysis. Interviews, observations and a workshop are used to capture data for qualitative  
186 analysis.

187 Figure 1 shows the essential steps of the strategy development framework proposed in this research. The first  
188 step focuses on analysing the current state in order to understand the business need. The second step involves  
189 clarifying the vision and strategy of the organisation on information management. The outputs from these steps  
190 are then analysed in the third step, taking into consideration the limiting and promoting factors, in devising the  
191 appropriate change strategy for the organisation. Details of each step are discussed in subsections 4.1 -4.5.

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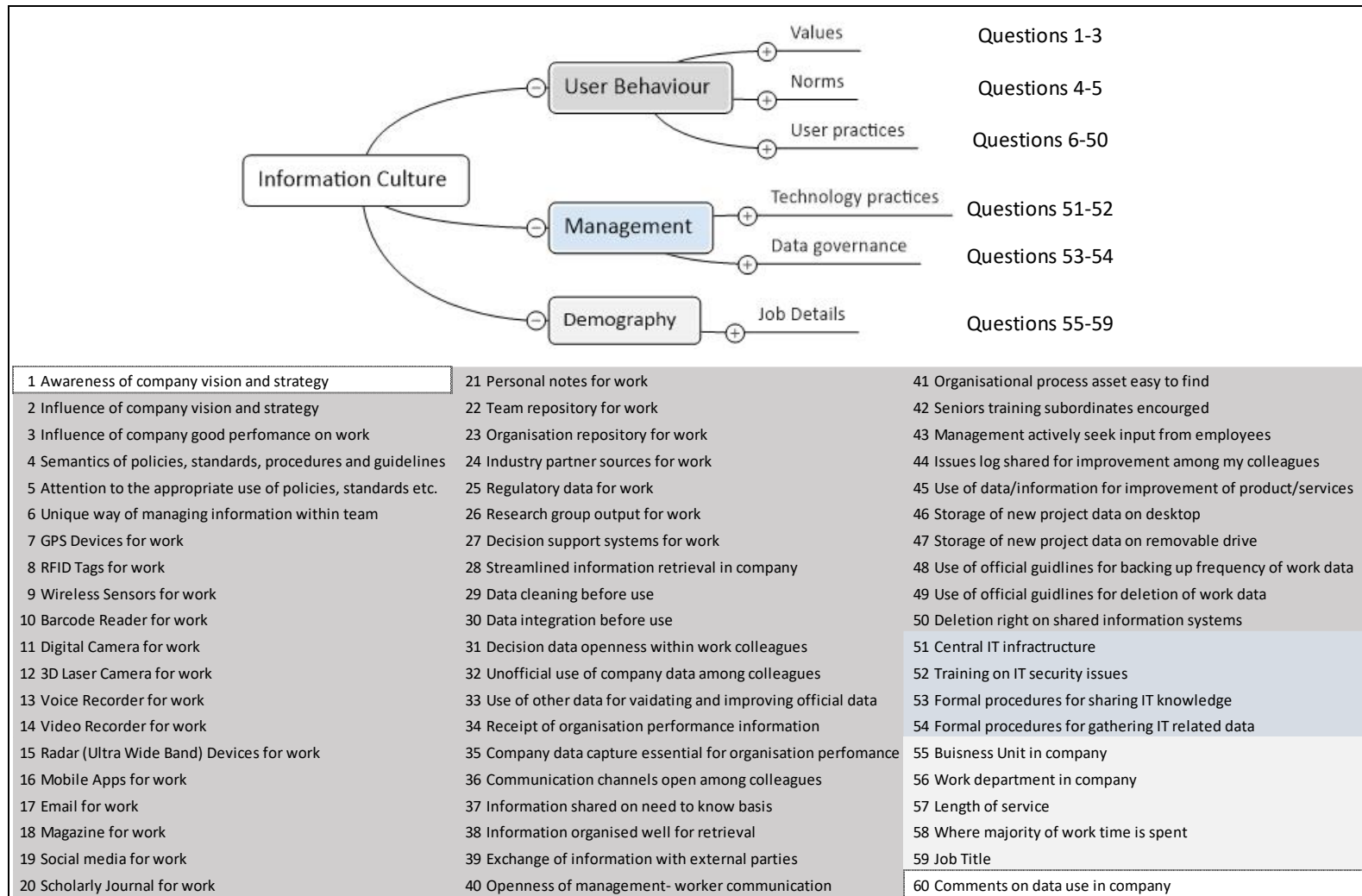
194 *Figure 1: Strategy development framework*

195 **4.1 Process audit**

196 This activity involves audit of the existing information culture in an organisation by studying the current  
 197 information processes and understanding the information management style in the organisation. This can be  
 198 achieved through a number of meetings, interviews and focus group sessions with key individuals working in the  
 199 company’s operation. Also, applicable company documents (old surveys, procedures, guidance, document  
 200 templates and forms) can be studied and an examination of the deployed information technology resources  
 201 carried out.

202 **4.2 Information culture survey**

203 This activity involves a questionnaire to elicit qualitative and quantitative data on information culture from the  
 204 various groups of people (professionals, support staff and company executives) who interact with project and  
 205 company data through an organisation’s information systems. The questionnaire (see Appendix A for example)  
 206 should contain, as a minimum, questions on the following themes: user behaviour, management practices and  
 207 demography. The user behaviour theme should include questions on values, norms and practices associated with  
 208 information use in an organisation. The management practices theme should include questions on information  
 209 technology (IT) support practices and data governance. The third theme, demography, should ask questions of  
 210 the respondents regarding their roles, length of service, location, and business area, amongst others. The survey  
 211 can also include open-ended qualitative questions for more detailed commentary. Figure 2 summarises the  
 212 questions in the Appendix A example. A majority of the survey sections contain questions with answers scaled  
 213 to a Likert scale of 1 (strongly disagree) to 5 (strongly agree).



214

215 *Figure 2: Questionnaire conceptual framework*

*ITcon Vol. 0 (2021), Akinyemi et al., pg. 7*



### 216 **4.3 Company vision and strategy**

217 This activity involves understanding the overall vision and strategy of a company by studying any  
218 documentation containing such information. It also involves conferring with the leadership of the organisation  
219 through formal meetings and informal discussions. In addition, any leadership presentation sessions must be  
220 monitored for any changes in the leadership's thinking. Lastly, a workshop session involving IT and core  
221 operations stakeholders should be used to clarify the scope of the change required and identify necessary actions  
222 to be taken.

### 223 **4.4 Information Management best practice review**

224 This activity involves investigation into what other organisations are doing that works very well. Also, practices  
225 that work very well in the different areas within the studied organisation should be investigated. Lastly, research  
226 into reported case studies in technical reports, published books and academic journals should be conducted. The  
227 best practice examples obtained from this exercise shall inform the change strategy.

### 228 **4.5 Risk assessment**

229 Using the results of the first two steps, Current State Analysis and Future State Analysis, a SWOT (Strengths,  
230 Weaknesses, Opportunities, and Threats) analysis (Gürel and Tat, 2017) is carried out to identify the internal and  
231 external factors that are helpful and detrimental to achieving the organisation's objectives. To define the strategy  
232 for the business, the result of the SWOT analysis should be presented to the company representative for  
233 validation. The company representative could then liaise with the operations board of the company and the  
234 technical experts supporting the effort in developing the change strategy to address the information management  
235 issues in the organisation. This should be done considering the recommendations from the SWOT analysis. The  
236 actions decided on should be ordered based on priority to form an implementation plan. A good ordering will  
237 ensure an incremental change that is beneficial to the organisation.

## 238 **5. CASE STUDY**

239 Presented in this study is the case of a leading construction business with the desire to radically turn around its  
240 information exchange performance and the overall productivity in its operations. The study domain for this case  
241 study includes the offices and construction project sites of the organisation which are spread across the UK. Our  
242 proposed strategy development framework is applied to develop an information management change strategy for  
243 the organisation. The detail is as follows.

### 244 **5.1 Current state analysis**

#### 245 **5.1.1 Process audit**

246 The business is part of a group, so its chief officers report to the group board. The operation of the business is  
247 divided into two regions, North and South, headed by chief operating officers. Each region has multiple delivery  
248 heads responsible for the divisions within the region. Each region has multiple projects ongoing. These projects  
249 are headed by project managers supported by functional personnel including surveyors, planners and engineers.  
250 Depending on the scope of the project, the organisation can be the main contractor or a subcontractor. The  
251 organisation's activities on construction sites are supported by the site administrators who help to coordinate the  
252 activities of other functional groups - except for planning, Health Safety Environment and Quality (HSEQ),  
253 engineering and quantity surveying that directly deal with the project managers. Also on the sites are document  
254 controllers who manage the transmittal of all data and documents, and commercial administrators who report to  
255 the surveyors on projects. In order to manage the knowledge of a diverse and geographically dispersed group of  
256 professionals, the company has an intranet portal specifically designed for simplified access to shared data and  
257 information. The described structure is the basis for reporting, and it goes from lower-level staff to top-level  
258 managers. Its main challenge is the availability of accurate, up-to-date data for timely compliance checking and  
259 decision making.

260 A review of the result of the company's 2018 survey on its commercial activities reporting showed that  
261 surveyors in the organisation spend approximately 70% of their time compiling reports. This is estimated to cost

262 an excess of about £50,000/month (£600,000/annum). Also, 60% of the 885 survey respondents said they are  
263 required to enter the same data in more than one place either “a great deal” or “a lot of the times”. This  
264 research’s investigation of the site operations of the studied organisation confirms the latter as it revealed  
265 extensive use of paper-based forms, requiring manual completion and additional processing to get data to  
266 electronic format. For example, the quality department of the business has 195 standard forms with 3028 fields  
267 to be completed for a one-time completion of all the forms. Some of the forms contain similar fields, meaning  
268 the same information is captured repeatedly, which is unnecessary. The process is also error prone and time  
269 consuming.

270 Review of controlled documents on the company's intranet revealed that the existing departmental processes are  
271 siloed with each department creating procedures and policies that are not properly coordinated with other  
272 departments. Interviews and focus group sessions with the process owners revealed that there are several  
273 processes without procedures; there are procedures that don't reflect what really happens on sites; and there are  
274 work steps hidden from the view of people required for their performance. In addition, different meanings exist  
275 for some terms used in the organisation e.g., procedure and guidelines. Furthermore, roles with similar  
276 responsibilities but different designations exist, generating some confusion in the organisation. Attempts by  
277 stakeholders within the studied business to design work processes or information management strategies result in  
278 conflicts because of differing viewpoints. This allows ‘feeder’ cultures (Martin, 2002), in this case software  
279 vendors, to fade in and out of attention.

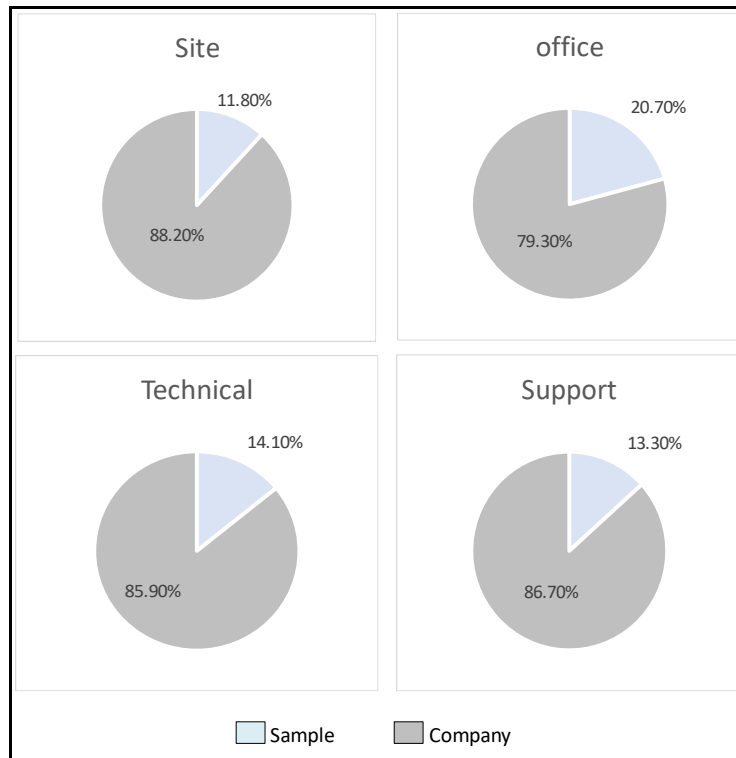
280 Regarding information systems, the IT department of the studied organisation has ongoing efforts to pull site  
281 data from different applications used in the business into a data warehouse. This is for the purpose of surfacing  
282 project data on live dashboards to aid decision support. This effort has yielded good result for the project  
283 planning team - while other functional teams struggle to decide what data they would like to see surfaced. The  
284 reason for the struggle is because proper requirements gathering and analysis is missing from the effort.  
285 Observation of current data management in the organisation revealed that different tools – IT systems and  
286 document templates - are used for similar activities across project sites. In some cases, staff members are  
287 creating their own document templates for data capture without any coordination with relevant stakeholders  
288 around the solutions being applied. The implication of this is that there could be data integration issues when the  
289 different data sets are to be combined. Another problem with site data management is that people who should not  
290 have write access to some repositories do have them. Edits by such unauthorised persons can lead to data quality  
291 issues. However, because there seems to be no real consequences for such action, people tend to continue with  
292 the same substandard data practices.

### 293 **5.1.2 Information culture survey**

294 The questionnaire survey was implemented online using SurveyMonkey (SurveyMonkey Inc., 2019), and  
295 participants accessed the survey remotely via a web page link sent to their official email addresses. The chief  
296 executive of the company helped to raise awareness about the importance of the survey by sending out a post  
297 through the social networking platform on the company’s intranet. The communications team of the company  
298 also sent out a message about the survey to the targeted groups within the company. The message contained  
299 financial incentive - in the form of prize draw - for completing the survey in order to ensure a good response  
300 rate. Each completed questionnaire formed a record in the exported data from the survey website. The database  
301 was subsequently cleaned and imported into SPSS (IBM Corporation, 2017) for statistical analysis, and NVivo  
302 (QSR International Pty Ltd, 2017) for text analysis on the qualitative responses.

303 In order to generalise the analysis result of the questionnaire survey on this research, the sample used must be  
304 representative of the population. According to Bryman (2012) the sample must be large enough to provide the  
305 necessary confidence in the result. The sampling technique explained in Taherdoost (2017) was applied. For this  
306 research, the population size - representing the people who interact with project and company data through the  
307 organisation’s information systems - is 1,192, confidence interval of 95% is selected in line with management  
308 research, and 50% selected for the percentage of population having a characteristic to maximise the variance and  
309 generate the maximum sample size as recommended by Bartlett et al. (2001). Given that the typical margin of  
310 error used in construction research is 10% (Dzokoto, 2015), the required sample size for the case study is 89.  
311 The questionnaire survey had 242 responses of which 171 of them were properly completed. Using the 171  
312 responses as the sample surpasses the minimum requirement. In fact, it represents a margin of error of 6.95%.

313 Based on the demographic data, 60% of the respondents work on project sites, while the remaining 40% work in  
 314 client and company offices. These represent 11.8% and 20.7%, respectively, of actual similar company staff as  
 315 shown in Figure 3. 82% of the respondents work in technical roles e.g., engineering and design, while the  
 316 remaining 20% work in support roles e.g., office management and human resources. These represent 14.1% and  
 317 13.3%, respectively, of actual similar company staff as shown in Figure 3. The sizes of samples for site and  
 318 technical staff relative to equivalent staff population fall within the 10% margin of error typical for construction  
 319 research. Lastly, survey data shows that 38.5% of respondents have worked in the organisation for less than 3  
 320 years, 47% for 3-10 years, and 14.3% for over 10 years.

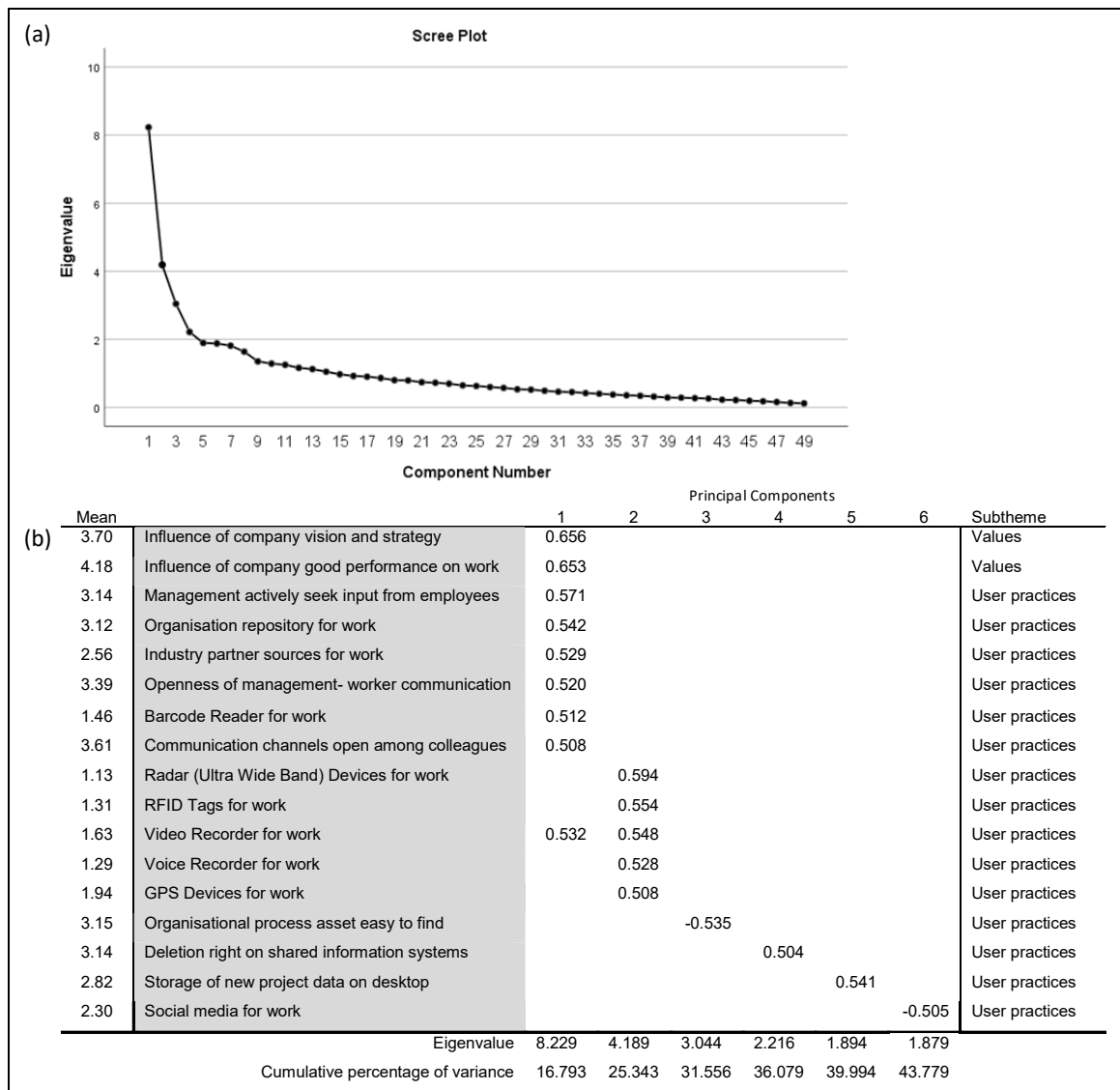


321

322 *Figure 3: Survey sample versus actual company staff distribution*

323 An exploratory factor analysis method - principal components analysis (PCA) (Jolliffe, 2011) - is used to reduce  
 324 the number of variables collected from the survey. This technique is good for a large number of variables, as in  
 325 this case, where we have 59 questions based on the framework in Figure 2. To select a subset of the larger set of  
 326 variables, the highest correlations with the principal components are considered. Figure 4 shows the PCA results  
 327 for the user behaviour theme of the information culture survey. To check that the data is suitable for factor  
 328 analysis, Kaiser-Meyer-Olkin measure of sampling adequacy needs to be  $\geq 0.6$  and the Bartlett's test of  
 329 sphericity needs to be significant with a value  $< 0.5$ . These tests were passed and a component loading value of  
 330 0.5 is selected as a threshold for including variables. The result shown in Figure 4(a) indicates the six  
 331 components with eigenvalues greater than 1.0 - a requirement for component selection. These six components  
 332 account for the majority of variance in the data set with a cumulative value of about 43.8%. The mean score of  
 333 each variable (as per responses to a given statement in the survey and shown in Figure 4(b)) indicates the degree  
 334 of agreement of respondents to the statement on the 1-5 Likert scale. Mean values below 2.5 indicate  
 335 disagreement with a statement, and values above 2.5 indicate agreement.

336



337

338 *Figure 4: PCA results for user behaviour theme of the information culture survey*

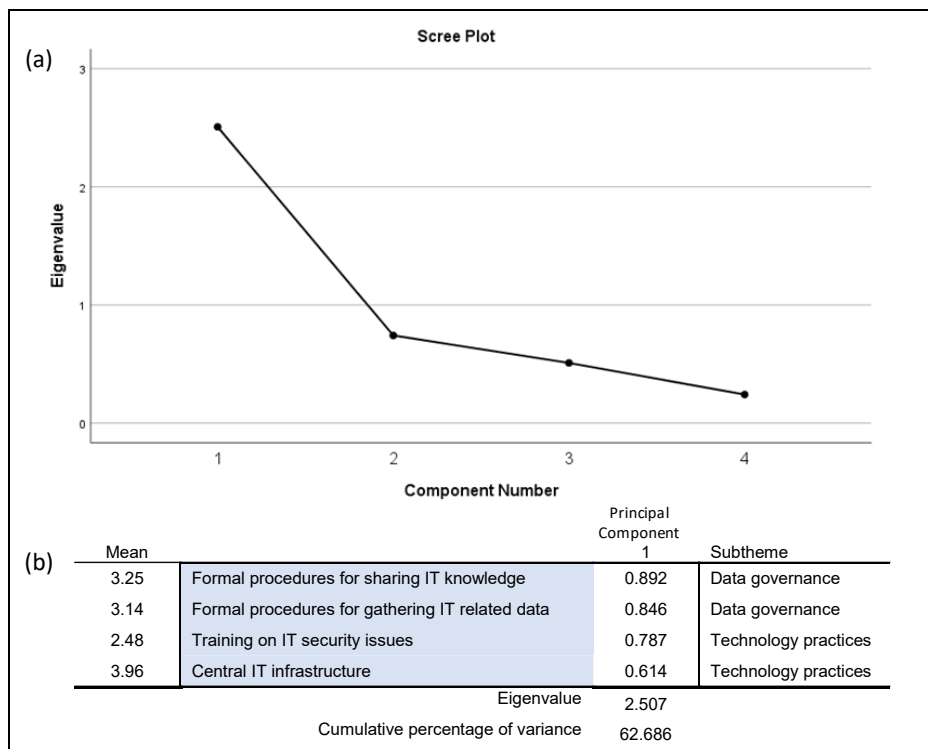
339 To understand the information user behaviour in the studied organisation, the nominated variables in Figure 4(b)  
 340 are discussed based on the corresponding subthemes in Figure 2. Considering the values of the organisation, the  
 341 analysed data indicates that the vision, strategy and performance of the organisation have a significant bearing on  
 342 how its staff use information. Other nominated variables focus on practices within the organisation. They cover  
 343 data capture, uses of data, data storage and purging of data. Regarding data capture, other than mobile apps and  
 344 digital cameras, other types of technologies are rarely used. Regarding information use, the organisation  
 345 adequately shares its performance information. This has a significant influence on its staff doing more good  
 346 work. There is also indication that information sharing in the organisation works well as survey data shows that  
 347 organisational process assets are easy to find, and communication channels are open between colleagues.

348 Other aspects of data use relate to transparency and proactive use of data. Regarding transparency, there is  
 349 positive indication that management-staff communication works. And with respect to proactive use of data, there  
 350 is indication that the management of the organisation actively seek input from the employees for decision  
 351 making. Regarding data storage and purging, an interview with the organisation's IT director revealed that there  
 352 is a goal to have all project data stored only on the organisation's shared repositories for data protection and

353 recovery reasons. However, the survey data shows that a significant percentage still copy new project data to  
 354 local computers and removable storage devices.

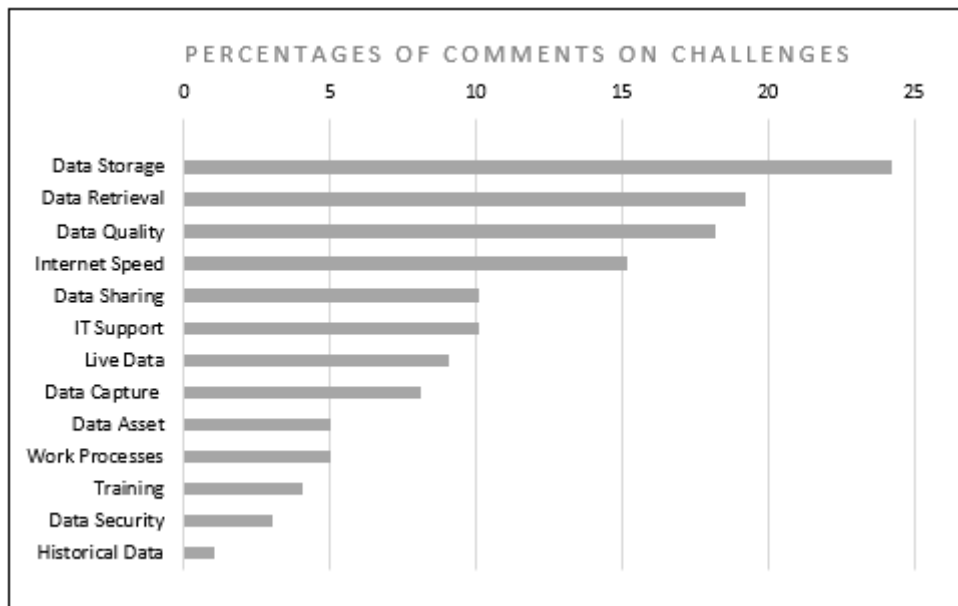
355 Figure 5 shows the PCA results for management style theme of the information culture survey. To check that the  
 356 data is suitable for factor analysis, Kaiser-Meyer-Olkin and Bartlett's tests were passed. Again, a component  
 357 loading value of 0.5 is selected as a threshold for including variables. The result shown in Figure 5(a) indicates  
 358 that there is only one component with eigenvalue greater than 1.0. This component accounts for the majority of  
 359 variance in the data set with a value of about 62.7%. The mean score of each variable is shown in Figure 5(b).

360 To understand the management style in the studied organisation, the nominated variables in Figure 5(b) are  
 361 discussed based on the corresponding subthemes in Figure 2. Considering the data governance environment in  
 362 the organisation, the analysed data indicates that formal procedures are used for gathering IT related data and  
 363 sharing IT related knowledge. Regarding technology practices, there is indication that a majority of the people in  
 364 the organisation are aware of the central IT infrastructure and its uses. This suggests good engagement by the  
 365 managers of IT resources. However, respondents are split on their take on training provided on IT security which  
 366 suggests there is still room for improvement.



367

368 *Figure 5: PCA results for management style theme of the information culture survey*



369

370 *Figure 6: Result of text analysis on information culture survey qualitative data*

371 Figure 6 shows the result of the analysis on the collected qualitative data. There were 100 comments and the  
 372 issues of most concern relate to data quality, retrieval, and storage in the organisation. A description of all the  
 373 issues raised is provided as follows:

- 374 • Data storage: there is a general complaint about data storage as a person may need to engage with  
 375 multiple individuals to retrieve all the data required for a task. The general sense is that available data  
 376 storage resources are not purposed according to the needs. There are multiple systems used in  
 377 different parts of the business, resulting in data silo issues. Also, there is a desire to have guidelines  
 378 to support data storage when working with principal contractors using different data management  
 379 systems. Because of uncontrolled access to some important repositories within the business, people  
 380 are worried anyone can move, edit or delete their data. Lastly there is the issue of duplicate folders,  
 381 resulting in document versioning issues.
- 382 • Data retrieval: there are challenges with the retrieval of data because the existing information systems  
 383 do not adequately support the task. Also, existing processes for storing data are inconsistent, so  
 384 people store data in different ways, making retrieval difficult.
- 385 • Data quality: manual data capture techniques on organisation's construction sites results in data  
 386 accuracy issues leading to a number of revisions having to be made before reports can be produced.  
 387 There are also data quality issues due to improper use of information systems, possible as a result of  
 388 poor training. Another source of the problem relates to data coming from external stakeholders,  
 389 which the organisation has limited control over. Inadequate quality checks before their application  
 390 result in data quality issues. Another cause of data quality issues relates to multiple formats. Data  
 391 available within the organisation sometimes exist in heterogeneous formats and require work for  
 392 current and future use. Format issues are due in some cases to inconsistent inputting, information  
 393 handover challenges, duplicity of uploads, edits due to uncontrolled access, and incomplete or  
 394 incorrect retrieval of data.
- 395 • Internet speed: connecting shared repository from construction sites can be very slow because of poor  
 396 internet service.
- 397 • Data sharing: there is a general sense of lack of communication between teams. Data sharing for  
 398 update and awareness among team members is not sufficient. This particularly affects lessons learned

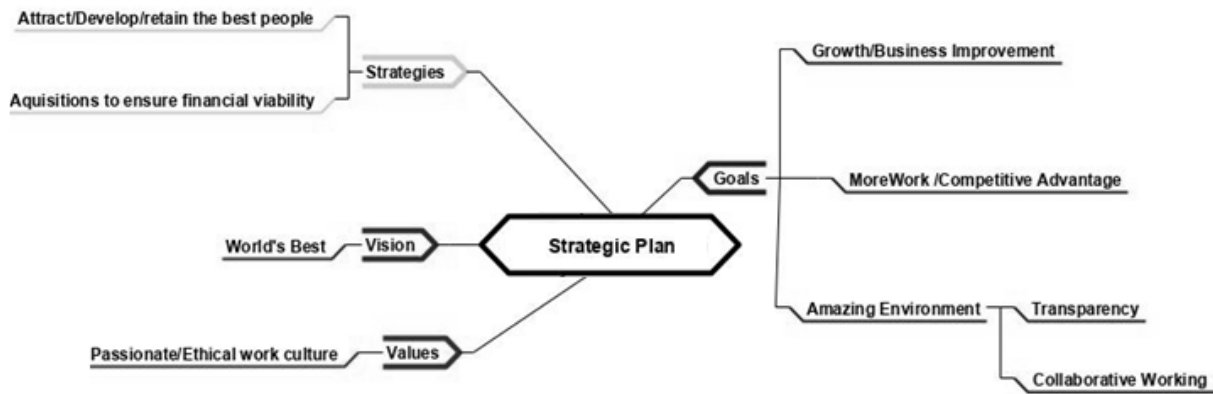
- 399 from previous projects. Members of the studied organisation are generally desirous of a centralised  
400 repository where they can upload and find updates on specific engineering and operational topics.
- 401 • IT support: one out of every ten respondents to the survey raised concerns about the application of  
402 multiple information systems, some with overlapping function, with little value. They argue the  
403 systems add additional steps to their work and desire a consolidation of the systems. Also, there is a  
404 desire to be able to work seamlessly with principal contractor systems while retaining current  
405 systems for work. Another desire is an automated system to give notification about the status of a  
406 document or data. Lastly, a group within the organisation believes that the capabilities of current  
407 systems are nowhere near their full potentials. Consequently, they should be explored further before  
408 time, money and effort are expended on new resources.
  - 409 • Live data: one out of every eleven respondents to the survey argue for the need of real-time data as it  
410 will make their work better and help them with time-critical decision making.
  - 411 • Data capture: in the studied organisation, many data capture exercises are needlessly repeated by  
412 multiple persons due to the poor communication between teams. Also, there are several manual data  
413 entry tasks that are time consuming. Lastly, due to poor handover between system operators there is  
414 inconsistent data input in systems.
  - 415 • Data asset: lack of organisational process assets because they are not archived. For example, lessons  
416 learned are not well captured at the end of projects. Also, data resources applied for successful  
417 projects are not converted to process assets.
  - 418 • Work Processes: the presence of too many procedures and sign offs for access to information  
419 resources is inefficient. This leads to unproductive waiting time. For example, a director sign off is  
420 required for an engineer to get access to data systems. Another example is the processing of  
421 information technology requests which requires the downloading and completion of an online request  
422 form, signing it, scanning it, and submitting via email.
  - 423 • Training: one out of every twenty respondents to the survey complained about inadequate training on  
424 the use of the information systems provided for work. Others desire the availability of e-learning  
425 resources on the use of information systems available for work.
  - 426 • Data security: at the different operation sites, there is a general sense that low priority is placed on  
427 data security, with workers for example complaining about lack of secure data storage.
  - 428 • Historic data: two individuals underscored the value of historic data to their work and the challenge  
429 to get access to such data within the studied organisation.

## 430 **5.2 Future state analysis**

431 The two steps in the proposed framework (Figure 1) for establishing the desired future state of a studied  
432 organisation are (i) the clarification of the business' vision and strategy and (ii) the identification of information  
433 management best practices. The application of the steps for the studied case are described as follows.

### 434 **5.2.1 Company vision and strategy**

435 Figure 7 summarises the vision and strategy position of the studied organisation's leadership. The goals for the  
436 business include growing and improving its capability, winning more work as a result of the competitive  
437 advantage achieved through developed capability, and creating an amazing work environment for its employees  
438 – a space where there is transparency and collaboration. The organisation's strategy is to attract, develop, and  
439 retain the best people. The leadership also plans to acquire assets that will ensure the organisation's financial  
440 viability. The vision of the organisation is to become the world's best in its areas of service by maintaining the  
441 organisation's value of passionate and ethical work culture.

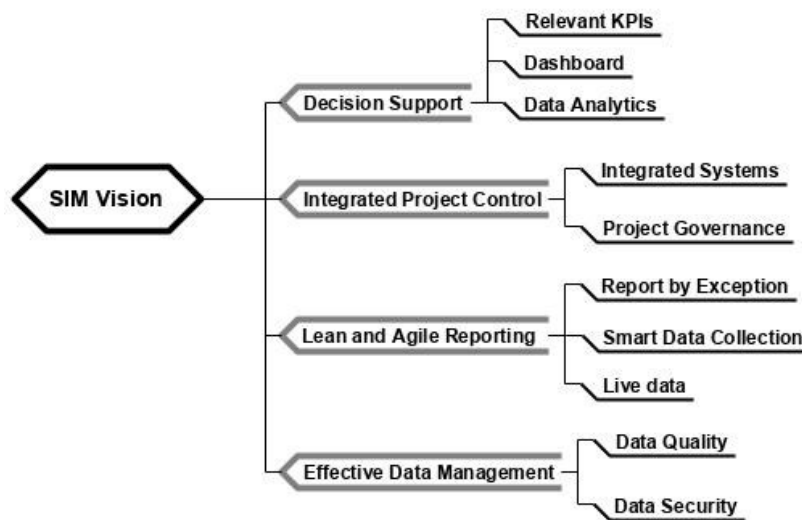


442  
443

444 *Figure 7: Strategic plan breakdown for studied organisation*

445 **5.2.2 Information Management best practices**

446 This step was completed using the workshop (Section 4.3) in the proposed strategy development framework. The  
 447 workshop participants are highly experienced in the best practices for information management. The overarching  
 448 strategic business plan of the organisation's leadership, as well as clear knowledge of the current state were used  
 449 as the basis for identifying information management practices appropriate for the organisation's Strategic  
 450 Information Management (SIM) vision at the tactical and operational levels. The components of the defined  
 451 vision are depicted in Figure 8 and described as follows:



452

453 *Figure 8: Strategic Information Management (SIM) vision*

- 454 • Decision support: the studied business has challenges with the availability of accurate, up-to-date  
 455 data for timely compliance checking and decision making. So, this component is focused on the  
 456 capability to make mission critical decisions, including predictions through analytics, using data  
 457 captured within the business processes. This will help to reduce the risk to the business, save on cost,  
 458 and win more work, allowing for the growth of the business. To achieve this, relevant KPIs will be  
 459 surfaced on dashboards.
- 460 • Integrated project control: the studied organisation has departmental processes that are siloed with  
 461 each department creating procedures and policies that are not properly coordinated with other  
 462 departments. Consequently, this component is focused on a unified approach to project control for



463 the purpose of achieving smooth business operations. This component is twofold. On one part, it is  
464 about linking information systems together e.g., planning and commercial applications for change  
465 management. On the other, it is about working to a project governance framework that provides  
466 clarity on roles and responsibilities for all stakeholders at each stage of a project's lifecycle. The  
467 framework will also integrate work process resources such as clear process maps, procedures,  
468 electronic forms, and decision criteria. This component of the SIM vision will promote collaborative  
469 working.

- 470 • Lean and agile reporting: data capture in studied organisation is inefficient there are challenges with  
471 the availability of the most up-to-date, necessary data for work. As a result, this SIM vision  
472 component is focused on the provision of access to accurate, up-to-date, project data, in a timely and  
473 controlled fashion, to staff who require data for work. It will consider the use of electronic forms on  
474 the web, or mobile apps, to capture data; the use of online cloud storage to store collected data;  
475 leveraging of live data already on the internet e.g., weather data; and automatic generation of reports  
476 by exception. This will eliminate unnecessary paperwork, streamline work processes, and enable  
477 timely compliance checking which will ensure transparency within projects.
- 478 • Effective data management: this is twofold. On one part, it will focus on the quality of data applied  
479 for work. It will deal with issues related to duplication of data, missing data, heterogeneous formats,  
480 data accessibility, system upgrades, data storage and eventual purging of data. On the other, it is  
481 focused on data security issues including access control and audit trail. This component is core to the  
482 SIM vision and holds the other components together.

### 483 **5.3 Risk assessment**

484 Figure 9 shows the SWOT analysis for rationalising a solution for the studied organisation. In terms of strength,  
485 the organisation is a leader in its service domain and its leadership is willing to fund innovative ideas with  
486 moderate risk profile. The organisation also has experience of collaborating with technology developers.  
487 Generally, its staff members have good understanding of the industry in which they operate - including the  
488 information management challenges - and are open to new technologies and ways of working. Regarding the  
489 organisation's weakness, all the data management issues enumerated in Section 5.1 (Figure 6) are contributing  
490 factors. In addition, stakeholders with conflicting interest, and the natural tendency of people to resist change are  
491 weakness factors.

492 In terms of opportunities, improving on information management in the organisation will lead to increased  
493 productivity, improved employee morale, streamlined and integrated work processes, and data driven decision  
494 making. These will reinforce the leadership position of the studied organisation. In terms of the threats, cost of  
495 some technologies could be prohibitive. Also, maintaining a common information management standard across  
496 board when collaborating with other organisations can be challenging. Lastly, regulations in different jurisdiction  
497 may mean unique information management requirements per location, leading to additional costs.

498 In order to achieve the opportunities that match the organisation's strength, staff with knowledge of the current  
499 challenges in the work processes can help in identifying the grey areas; and the organisation can leverage  
500 existing alliances and past experience with technology developers in streamlining work processes and  
501 developing technology tools that can help in improving productivity. Such collaboration can lead to innovation  
502 and solidify the organisation's leadership in the construction industry. Such move will be well supported and  
503 funded by the company leadership who seem to be open to innovative ideas with moderate risk profile. An  
504 opportunity also exists with experienced and curious staff. These individuals can be challenged to think of  
505 opportunities to apply data intelligently for decision support and prediction. Engaging them this way will  
506 improve their morale as they will feel like they are a part of an important paradigm shift.

INTERNAL	
POSITIVE	<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>• Leadership open to innovative ideas</li> <li>• Staff with knowledge of the challenges</li> <li>• People with industry experience</li> <li>• Inquisitive staff open to new technologies and ways of working</li> <li>• Funds</li> <li>• Existing alliances and past experience with technology developers</li> <li>• Reasonable risk tolerance</li> <li>• Industry leader in service area</li> </ul>
	<p><b>Weakness</b></p> <ul style="list-style-type: none"> <li>• Data management: <ul style="list-style-type: none"> <li>*knowledge silos</li> <li>*manual data work</li> <li>*inconsistent work processes,</li> <li>*document control issues</li> <li>*duplication in data capture</li> <li>*inconsistent use of terms</li> <li>*data quality issues</li> <li>*no consequences for data breaches</li> </ul> </li> <li>• Conflicted stakeholders</li> <li>• Resistance to change within organisation</li> </ul>
	EXTERNAL
	NEGATIVE
	<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>• Increase in work productivity</li> <li>• Improved employee morale</li> <li>• Leadership in innovation</li> <li>• Streamlined and integrated work processes</li> <li>• Data as strategic asset applied for decision support and prediction.</li> </ul>
	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>• Collaboration with partners</li> <li>• Unique requirements for operations in different jurisdiction</li> <li>• Cost of information technology</li> </ul>

507

508 *Figure 9: SWOT analysis for SIM vision in studied organisation*

509 In order to overcome the weaknesses within the organisation and benefit from the opportunities that exist with  
510 positive information culture, communication between teams and departments needs to improve. This should be  
511 targeted at improving productivity, quality of services, and levels of trust and commitment among co-workers.  
512 Such cultural change would allow the sharing of process assets hidden away in the organisation. The resources  
513 coming to the fore would reveal the variations in similar processes within the organisation. Attempts by  
514 collaborators to benchmark the latter processes would reveal stakeholders with vested interests. Collectively  
515 aiming for data as strategic asset in the organisation will help address data issues related to quality, control,  
516 capture and semantics.

517 To address the organisation's vulnerability to outside threats, it needs to pull its weight by applying its strengths.  
518 For example, when the construction business partners with organisations with negative corporate or workplace  
519 culture, this may rub off on the employees of the business. In such a scenario, people with significant industry  
520 experience within the studied organisation should be relied on for guidance. The organisation in this case study  
521 has over 100 sites across the UK. This means different Information requirements for regulatory compliance in  
522 different regions. Again, people with the right experience should be relied on for guidance. Where the cost of  
523 information technology is a concern, justification in the form of cost-benefit analysis that is mindful of the direct  
524 and indirect benefits of the technology solution should be provided before approval for purchase.

525 The concluding part of this analysis looks at how the studied organisation can limit its weakness to avoid making  
526 the organisation more susceptible to external threats. An important consideration is adequate management of  
527 data issues in order to meet regulatory compliance requirements. Also, adequate management of data quality  
528 issues by exploiting the capabilities of existing technology resources will prevent unnecessary IT costs. Lastly,  
529 where there is resistance to change within the organisation, the company management should: lead change  
530 management by sharing a clear vision, invest in resources that can help in educating everyone affected by the

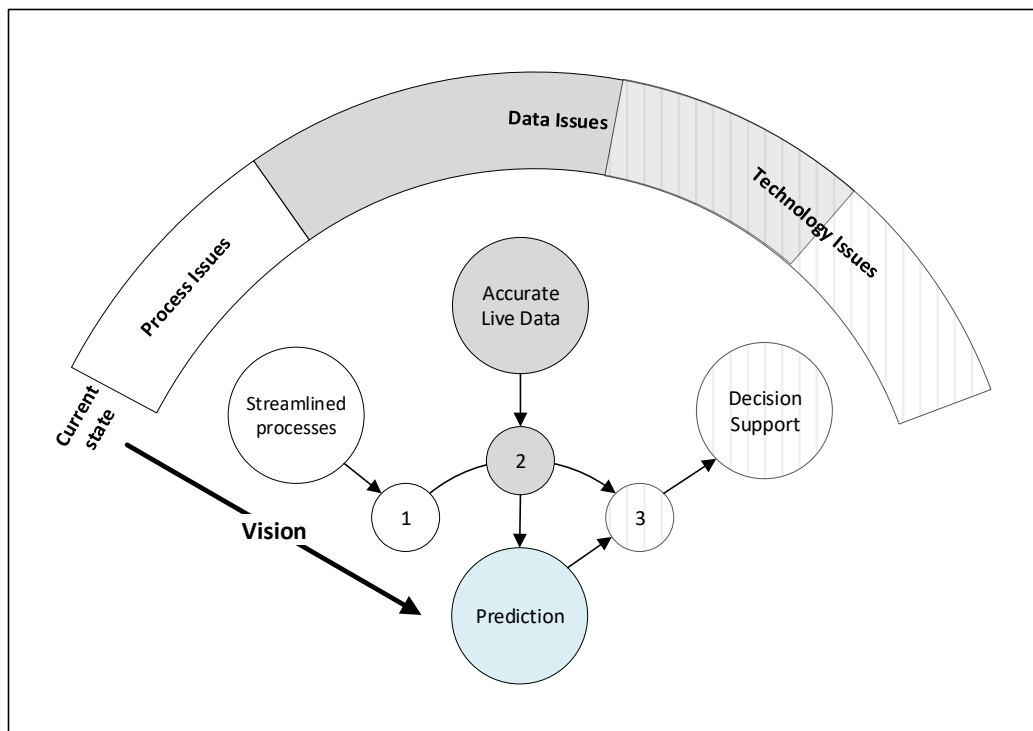
531 change, and engage directly to help address the concerns of those being resistant - particularly the influential  
532 stakeholders.

#### 533 **5.4 Change strategy**

534 Formulating a change strategy for the described SIM vision requires consideration of the current information  
535 culture of the business. In terms of decision support, this study revealed that management of the organisation  
536 regularly get input from the employees for decision making. This practice can be used to support data capture for  
537 KPIs. Also, the current practice of making decisions based on experience and gut feeling, due to unreliable data,  
538 needs to evolve and better lean on the empirical insights that analytics can offer. That will improve risk  
539 management in the business. Regarding integrated project control, current practices like good management-staff  
540 communication, good information sharing between colleagues, and traceable teamwork effort should be  
541 leveraged to achieve integrated project governance. Contrarily, the practice of staff members creating individual  
542 document templates for data capture without any coordination must be dealt with by enforcing a common  
543 standard.

544 In achieving lean and agile reporting, the current practice of using mobile apps for work should be extended for  
545 data collection to change the current pattern of extensive use of paper-based forms. Also, the importance of  
546 sharing the organisation's performance information, a practice employees indicate motivates their work, should  
547 be emphasised to gain support for the transition. For effective data management, the occurrence of unauthorised  
548 edits needs to be controlled with technology to ensure data integrity. Individuals with conflicted values pushing  
549 for specific technology or service provider should be tempered to ensure fit for purpose solutions are adopted.  
550 Already, there is report that there is good support from the IT team, and with IT resources. These practices  
551 should be continued and extended to include IT sourcing, to ensure reliable internet service is available to  
552 support the use of online resources, and staff training on data protection, to curb the practice of copying project  
553 data to local computers and removable storage devices.

554 Based on the information culture survey result, knowledge of the vision, strategy and performance of the  
555 organisation has a significant bearing on how its staff use information. So, communicating the SIM vision in a  
556 simple way is an important change strategy element. Figure 10 depicts the recurring themes in the change  
557 strategy and prioritizes them in three steps. The first step is to address process related issues. This will involve  
558 revising process resources, e.g., procedures, document templates and forms, to eliminate redundant steps. Also,  
559 this step will help benchmark inconsistent processes within the organisation. The second step is to address all the  
560 data issues raised. This will help turn data into an asset that can be applied in prediction and decision support.  
561 There is also the need to clearly map the data generation and usage to the processes identified in the first step.  
562 The third step is on technology support. This step will involve audit of existing technology resources to identify  
563 their limitations and opportunities for further exploitation. The audit exercise will help identify the technology  
564 needs in the organisation which will be the basis for technology sourcing or development. Fulfilling the latter  
565 step and combining the outcome with live data of excellent quality will help achieve the information  
566 management objectives of the organisation and improve its information culture.



567

568 *Figure 10: Change strategy map*

569 Finally, an appointed team is tasked with achieving the future state defined, considering the risk mitigation  
 570 strategies highlighted in the SWOT analysis and the current information culture of the business. The team will  
 571 develop a detailed delivery roadmap based on the scope defined for the desired future state. The roadmap will  
 572 include, at the minimum, estimated timelines, estimate of resources, stakeholder roles and responsibilities,  
 573 communication plan, deliverables, and the plan for integration and rollouts.

574 **6. CONCLUSION**

575 This study proposes a strategy development framework for information management and demonstrates its  
 576 application for a construction business. The proposed framework incorporates a cultural analysis framework that  
 577 combines qualitative and quantitative research techniques in investigating the information culture of an  
 578 organisation. The results of the culture, process and company vision investigations in the studied organisation  
 579 were applied in developing a vision for its information management. The culture investigation helped to uncover  
 580 the user behaviour and management practices, process audit revealed the problems with systems and processes,  
 581 and vision clarification helped to establish the aspiration of the organisation's leadership. In terms of contribution  
 582 to the studied organisation, this study helped to outline specific actions for addressing the identified challenges  
 583 and meeting the information needs for a better information culture – an output valuable to all construction  
 584 businesses. Given that the combination of circumstances encountered in the studied organisation may be unique,  
 585 and that businesses regularly revisit their strategies to accommodate pressing enterprise environmental factors,  
 586 the strategy established in the case study may require reconsideration in new contexts. Notwithstanding, the  
 587 strategy development framework proposed in this work should be applicable to construction businesses,  
 588 internationally. For the next step of this research, the implementation of the developed strategy will be examined  
 589 for its effectiveness and challenges.

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