Information-Sharing and Technological Trends among Small and Medium-Sized Enterprises

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ABSTRACT

Digitalization is an important factor for small and medium-sized (SMEs) contractors. This study examines different elements impacting the digitalization process as well as innovation and technological trends amongst SMEs. An online questionnaire was designed, and 70 responses were collected. Four variables of organizational, technological, economical, and social were factor analyzed through which two components of 'resources' and 'human force management' were identified. The relationships between firm size, information-sharing, and software usage were further tested via Pearson Chi-Square Test of Independence. It was concluded that no association existed among those three variables and technology usage was found to be minimal among the firms.

KEYWORDS

Digitalization; BIM; SMEs; Construction; Innovation

I. INTRODUCTION

All efforts toward innovation and digitalization are dependent upon information and knowledge transfer. The small and medium-sized enterprises (SMEs) that do not participate in information-sharing do not have any motivation to innovate. SMEs do not tend to share any ICT information or apply ICT for strategic purposes compared to larger enterprises (Hua, 2007). The Government's Digital Inclusion Strategy (Cabinet Office 2014), for example, highlights that over a third of SMEs do not have a website; capital required to buy technology is not feasible; and that many lack the necessary data and digital capability (Dainty, Leiringer, Fernie, & Harty, 2017). Normally, one of the common ways in which information is shared by SMEs is through traditional and conventional face-to-face communication with no printed copies passed around, and since the SMEs have a nature of scarcity of time and resources, information flow is extremely limited (Lu, Sexton, & Abbott, no dates, pp. 5 & 6). To survive this issue as the focusing point of the SMEs, innovation is a requirement, and to innovate; all the associated risks must be accepted. To undertake risks, there is a need for information sources to be shared, and innovative contacts to be kept current (Sexton and Barrett, 2003). Otherwise, the stability of the firms and their development would be fade out sooner or later. The reason the small firms are not willing to undertake risks is the fear of unknown in forms of security of information, privacy of business, authenticity of information, and the fear of jeopardizing the existing competitive advantage (Love, Irani, Li, Cheng, & Tse, 2001).

The distinctive identity of construction industry is its fragmentation nature and secondly its information intensive essence through which a huge amount of information should pass among owners, clients, consultants, stakeholders, contractors, subcontractors, suppliers and state officials and authorities. This is a fact that the industry for certain reasons cannot or do not intend toward providing the necessary instruments such as ICTs to manage the information transfer. To capture,

sort, communicate and act on this information is the predominant difficulties of SMEs these days. Since SMEs require a plethora of stakeholders, sometimes, accumulation of knowledge is problematic especially when there is an adversarial relationship among stakeholders. Fragmentation itself in SMEs is a big cause for not producing information and consequently, it limits the capturing and sharing of information as well as learning and innovation. This normally exempts SMEs from achieving competitive advantages (Alashwal, Abdul Rahman, & Beksin, 2011). This paper will investigate the technological trends among SMEs as well as factors influencing the digitalization process by means of statistical analysis.

II. BACKGROUND

BIM has been discussed in both academia and industry as a tool toward digitalization within the construction sector. However, its implementation has faced some challenges for construction firms, particularly SMEs. In an evaluation survey regarding BIM among UK contractors in 2012, the results show that 64% never used BIM and in a comparison between large and SME contracting firms, it indicates that 21% of large and 73% of SMEs have never used BIM. Also, 78% of the former and 57% of the latter have a positive attitude toward BIM as beneficial to their businesses (Dainty, Leiringer, Fernie, & Harty, 2017). BIM implementation is a global issue that has affected all most of the countries across the world. For instance, there is a strategic BIM mandatory deadline for all construction projects including complex projects in Italy from 2022 to 2025 to move and mobilize toward innovation and digitalization. According to the Global Competitiveness Report in 2017, Italy has been ranked 34th among 140 countries in innovation, 24th in PCT Patent applications, 29th in capacity for innovation and has a decline of 8.9% in number of construction firms as well as a 32.2 % drop on production. It also has a 17.3% drop on profitability and employment and a 17.2% decline on turnover and gross operating surplus in 2010-2016 within the construction sector. Consequently,

Italy has been classified in general as the **Moderate Innovator** based on the European Innovation Scoreboard 2017 (European Construction Sector Observatory, 2018). This obligatory four-year deadline could move Italy to an **Advanced Innovator** if all parties from government agents to academic faculties, and R&D offices with cooperation and tendency of SMEs owners towards digitalization mobilize.

Innovation in SMEs means creation, management, and exploitation of knowledge to achieve competitive advantages and performance to satisfy the clients. Based on research findings, the ICTs that SMEs tend to adopt needed to 'contribute to the business in a quick, and tangible fashion, which can fit into existing organizational capabilities. Any technology that is too far removed from this "comfort zone" is seen to require too much investment and to contain too much risk, and thus tends to be intuitively and swiftly sifted out' (Sexton, Barret, & Aouad, 2006). Although the idea of BIM solving a host of long standing problems seems a long way from the definition of BIM as a digital model for better decision making, its role in affecting structural and cultural reform of the sector is now firmly established (Dainty, Leiringer, Fernie, & Harty, 2017).

Innovation and digitalization are an opening to SMEs closed doors. Any postponement not only is concomitant with losing the market competition, but also endangers the whole firm's innovative capability. "Companies that continue to ignore the digital wave will struggle to survive." (Joblot, Deneux, Paviot, & Lamouri, 2017). As for construction operations, innovation is a new way of doing things. It is a new discovery of fulfilling or performing an ordinary traditional construction activity to a new alternative. It is an ongoing pragmatic problem-solving procedure on-site before the start of the project (Sexton and Barrett, 2003). Therefore, innovation does not occur in an abstract setting, it is a matter of everyday performance and experience.

III. METHODS

This research was conducted based on a structured on-line questionnaire that was distributed to people within the construction industry in Italy, Brazil, and Columbia. It included contractors, subcontractors, suppliers, architects, engineers, and owners. 70 responses were received among which 23 were from micro firms having 1 to 9 employees, 26 from small-sized firms with 10 to 50 employees, 10 from medium-sized firms between 51 to 100 employees, 9 from large firms with over 100 employees, and 2 that did not indicate. The questions were multiple choice and Likert scale questions on digitalization and BIM-based Supply Chain Management. Statistical methods such as Factor Analysis, Chi-Square Independence Test, and Fisher's Exact Test were utilized to examine the association between different factors influencing digitalization among the construction contractors. The main variables consisted of organizational, social, economical, and technological aspects of BIM along with software usage and level of information-sharing by construction contractors.

IV. RESULTS AND DISCUSSION

4.1. Information Exchange and Technology

As shown in Fig. 1, Brazilian companies are more active in private project, whereas; Columbian companies are engaged in both types of projects almost equally, while Italian firms showing more involvement in public projects. Fig. 2 shows the efficiency of information exchange throughout the construction life-cycle, majority of respondents gave a rating of 3 from scale of 1 to 5, which indicates that they believe it is somewhat efficient.

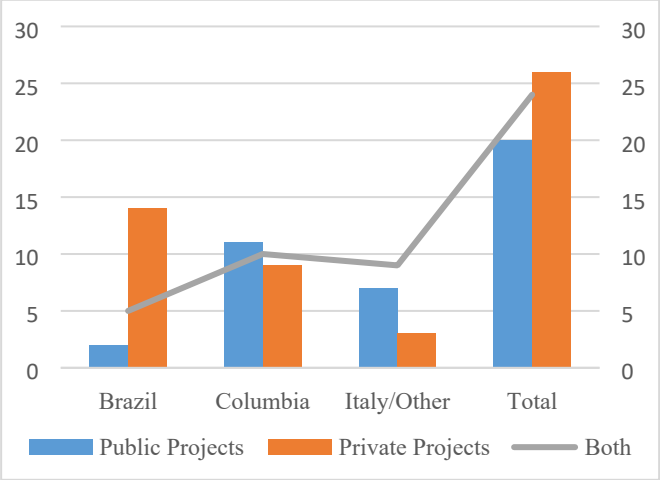

FIGURE 1. PROJECT TYPE.

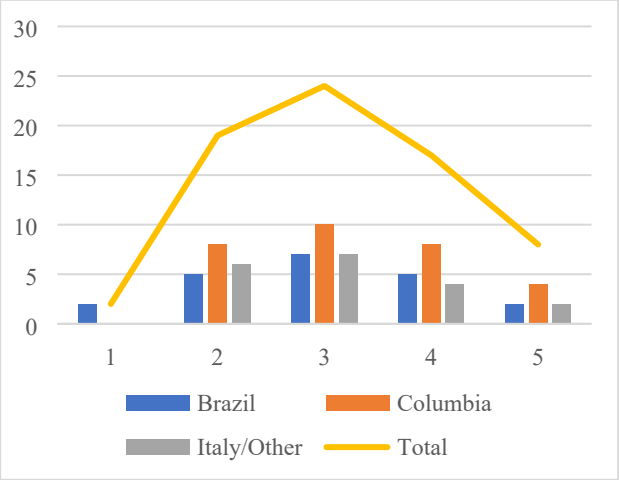

FIGURE 2. INFORMATION EXCHANGE.

Majority of SMEs often use more conventional methods in forms of paper documents, pictures, graphics, and the like. New technologies and software usage is a new development for majority of SMEs in their business. Fig. 3 indicates the application of software usage and its utilization for communication and information exchange. Among 58 companies almost 64% or (37 firms) do not use any special type of software according to responses taken from all respondents for this study. When asked about the types of tools used for information exchange, 12 respondents from Italy mentioned emails and 4 indicted using phone to communicate with stakeholders while numbers for Brazil were 6 and 4, respectively. The Columbian companies resorted to Cloud and email. The following trend is depicted in Fig. 4.

Further, the sample respondents showed familiarity with BIM, and improvements that may be achieved by utilizing BIM in construction supply chain management. The corresponding bar and line chart below in Fig. 5 displays the efficiency of BIM in supply chain management and its trend. As seen, the control of processes, cost efficiency, and quality control have the highest ratings.

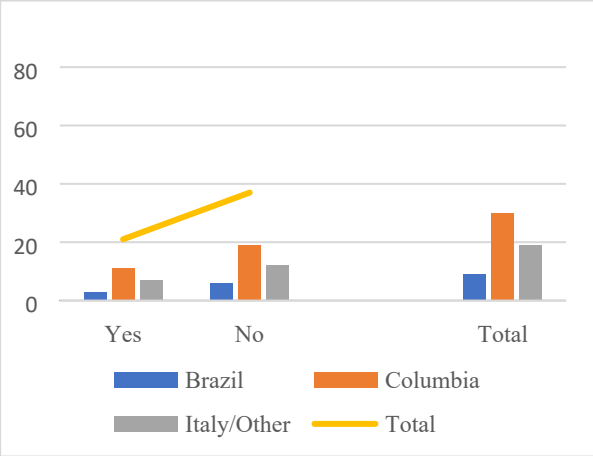

FIGURE 3. SOFTWARE USAGE.

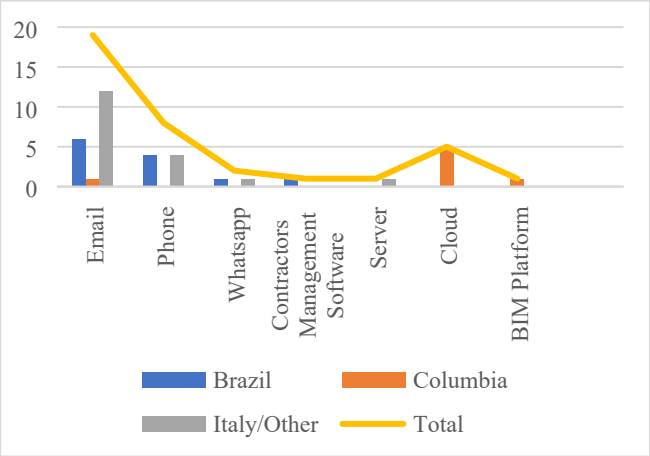

FIGURE 4. COMMUNICATION TOOLS.

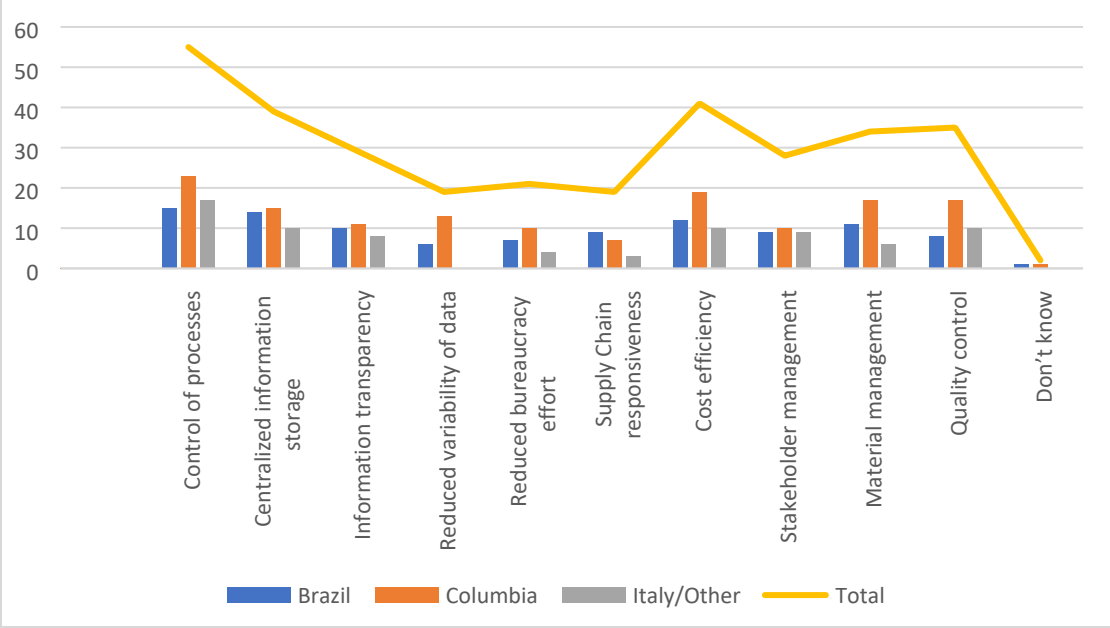

FIGURE 5. BIM EFFICIENCY IN SUPPLY CHAIN MANAGEMENT.

4.2. Factor Analysis

To determine the number of elements that impact BIM in Supply Chain Management, four variables, namely, organizational, economical, social, and technological were factor analyzed out of which two components of 'resources' and 'human force management' were created. According to

table 1, “Total Variance Explained”, the cumulative percentage of variance after rotation accounted for 82.137% of the total variance by the two factors.

Table 1. Total Variance Explained

Total Variance Explained									
Component	*Initial Eigenvalues*			*Extraction Sums of Squared Loadings*			*Rotation Sums of Squared Loadings*		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	2.540	63.506	63.506	2.540	63.506	63.506	1.718	42.955	42.955
2	.745	18.631	82.137	.745	18.631	82.137	1.567	39.182	82.137
3	.423	10.579	92.716						
4	.291	7.284	100.000						
Extraction Method: Principal Component Analysis.									

The Rotated Component Matrix, shown in table 2, indicates the internal correlation of each factor. The first component includes ‘Economical’ and ‘Technological’ variables with correlation coefficient of 0.920 and 0.832, respectively. The second component consists of ‘Organizational’ and ‘Social’ variables with correlation coefficients of 0.912 and 0.762, respectively.

Table 2. Rotated Component Matrix

Rotated Component Matrix[a]		
	Component	
	1	2
Organizational	.154	.912
Economical	.920	.173
Technological	.832	.354
Social	.394	.762
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

4.3. Chi-Square Test

The association between information sharing, software usage, and firm size was tested by Fisher's Exacts Test based on Chi-Square Independence on the following hypotheses:

H_0 = There is no association between software usage and information-sharing efficiency.

H_1 = There is an association between software usage and information-sharing efficiency.

H_0 = There is no association between information sharing efficiency and firm size.

H_1 = There is an association between information sharing efficiency and firm size.

As table 3 shows, the value of Fisher's Exact Test statistic is 3.905, this would result in a P-value of 0.429, which is more than the given an alpha level of 0.05. Therefore, we fail to reject H_0, which states there is no relationship between software usage and information-sharing efficiency. In other words, the association between two nominal variables is not significant.

Table 3. Software and Information Sharing

Chi-Square Tests						
	Value	*df*	*Asymptotic Significance (2-sided)*	*Exact Sig. (2-sided)*	*Exact Sig. (1-sided)*	*Point Probability*
Pearson Chi-Square	4.255[a]	4	.373	.396		
Likelihood Ratio	4.925	4	.295	.366		
Fisher-Freeman-Halton Exact Test	3.905			.429		
Linear-by-Linear Association	.001[b]	1	.973	1.000	.533	.093
N of Valid Cases	70					
a. 4 cells (40.0%) have expected count less than 5. The minimum expected count is .77.						
b. The standardized statistic is -.034.						

Further, table 4 shows the relationship between information-sharing efficiency and firm size. The value of Fisher's Exact Test statistic is 14.373, this would result in a P-value of 0.571, which is more than the given an alpha level of 0.05. Therefore, we again fail to reject H_0, which states there is no

relationship between information sharing efficiency and firm size. It is confirmed that the association between two nominal variables is not significant.

Table 4. Firm Size and Information Sharing

Chi-Square Tests						
	Value	*df*	*Asymptotic Significance (2-sided)*	*Exact Sig. (2-sided)*	*Exact Sig. (1-sided)*	*Point Probability*
Pearson Chi-Square	15.362[a]	16	.498	.482		
Likelihood Ratio	15.433	16	.493	.592		
Fisher-Freeman-Halton Exact Test	14.373			.571		
Linear-by-Linear Association	1.027[b]	1	.311	.318	.170	.025
N of Valid Cases	70					
a. 19 cells (76.0%) have expected count less than 5. The minimum expected count is .06.						
b. The standardized statistic is 1.013.						

V. CONCLUSION

The research goal for this study was to identify the needs of construction firms to apply new technological innovations toward information communications. The technological trends were evaluated based on innovation and information-sharing. The contractor and designer were heavily involved during the information-sharing process and most of the information was shared during design, procurement, and construction phases. Based on the responses, it is apparent that technology usage is very minimal within the firms, even though familiarity with benefits of technology and digitalization exists. Further, two components of ‘resources’ and ‘human force management’ were identified as main factors for BIM-based Supply Chain Management. The association between firm size, information-sharing, and software usage was tested and found not to be significant.

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