



**The impact of digital transformation on formal and informal organizational structures of large architecture and engineering firms**

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## The impact of digital transformation on formal and informal organizational structures of large architecture and engineering firms

### Abstract

**Purpose** – The objective is to understand the impact of digital technologies adoption on the forms of organization of large architecture and engineering firms. Network theory has attracted scholarly and managerial attention, particularly from the perspective of the changes of project organization. However, little research focuses on network theory as a lens for understanding and managing the new forms of firms' organization. Additionally, conventional organizational analyses are hampered by the lack of methods for understanding the changes in roles and relationships due to the adoption of digital technologies and examining their impact on organizational structures.

**Design/Methodology/Approach** – To address this gap, this research adopted a mixed-method case-study approach. This approach combined interviews, regular check-ins, and document analysis with data mining and social network analysis (SNA) to capture the changes of intra-organizational roles and relationships and for understanding their impact on the firm's organizational structure. Using the data gathered, we created a dendrogram that shows the formal organizational structure, a sociogram that displays the informal organizational structure, and a network map that visualizes the interplay between the two structures.

**Findings** – From this analysis, we identified four main findings: 1) informal roles – as go-to people for advice and information about digital technologies – play within A/E firms facing digital transformation; 2) such go-to people operate through informal networked relationships and beyond their formal roles; 3) most of these relationships do not overlap with the formal reporting relationships; 4) the combination of both these roles and relationships create an informal social network. We also show how managers can use SNA to understand the changes in roles and relationships due to the adoption of digital technologies and to diagnose their impact on organizational structures.

**Originality/Value** – This research contributes to the literature of organizational design and change management from a network perspective in the context of the digital transformation of large A/E firms. It provides a systematic data-driven approach to understanding the changes of intra-organizational roles and relationships within A/E firms facing digital transformation and to diagnosing the impact of these changes on firms' organizational structures.

**Keywords** Digital transformation; Knowledge management; Network; Organizational change

**Paper Type** Research paper

### 1. Introduction

Digital technologies and processes, such as Building Information Modeling (BIM), have the potential to transform the way professionals work and interact within and between firms (Grilo and Jardim-Goncalves, 2010; Sebastian, 2011). Central to such transformation is the development of innovative forms of project and firms' organization (Dossick and Neff, 2010). The current theory emphasizes the importance of investigating these new forms of organization associated with digital transformation and understanding how they can be designed and managed (Papadonikolaki et al., 2019). Scholarly work has noted in particular the need for studying the features of these new forms of organization. For this purpose, research has started to explore the power of network theory particularly for designing and managing project organization (Chinowsky and Taylor, 2012; Pryke, 2012; Zheng et al., 2016). This article contributes to that conversation by highlighting another key perspective: the power of network theory for the design and management of *firms' organization*. Particularly, the lens of network theory is used for understanding the changes of intra-organizational roles and relationships within A/E firms

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3 facing digital transformation and to diagnosing the impact of these changes on firms' organizational  
4 structures.

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6 Within a firm organization, we can identify both formal and informal organizational  
7 structures. On the one hand, *formal structures* determine how roles and responsibilities are assigned and  
8 how different management levels share information and make decisions through formal relationships  
9 (Zenger et al., 2002). On the other hand, *informal structures* includes those roles and relationships  
10 created informally and unofficially and arising outside the formal organizational structure (Cross and  
11 Parker, 2004; Cross and Sproull, 2004). The literature about organization design and management  
12 acknowledges the importance of both formal and informal structures for understanding organizations  
13 and their performance (Soda and Zaheer, 2012). However, most research has focused on these two  
14 structures independently and has not fully understood their *interplay* (Scott, 2013; Wang et al., 2018).

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16 Additionally, research on designing and managing firm organization has been hindered by the  
17 absence of effective methods for analyzing both these structures, as well as their interplay. These  
18 considerations motivate our analysis of both formal and informal organizational structures, and  
19 the interplay between these two, through a social network analysis (SNA) approach. SNA has been  
20 shown to be an effective and emerging tool in construction research that uses systems theory to  
21 describe how relationships influence behavior (Chinowsky et al. 2008; Zheng et al. 2016). Central to  
22 our methodology is considering formal and informal organizational structures in terms of formal and  
23 informal *networks* (Kratzer et al., 2008).

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25 One emerging trend in organizational design and management argues for the benefits of more  
26 horizontal networked structures - as opposed to vertical hierarchical ones (Bersin et al., 2017).  
27 Accordingly, Kiron et al. (2016) point out that digitally-maturing firms are moving away from  
28 hierarchical towards networked structures, where the conventional question "For whom do you  
29 work?" is being coupled with "With whom do you work?". In line with this view, Soda and Zaheer  
30 (2012) conceptualize high-performing organizations "as a complex system of both formal and  
31 informal elements, generated by formal structures and the informal social network." Thus, we echo  
32 Fitzgerald et al. (2013) and Kane et al. (2015) in defining digital transformation as a transformation of  
33 processes, organizations, and delivery methods that can enable firms to grasp the full benefits from the  
34 adoption of digital technologies.

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36 Therefore, large A/E firms undertaking a digital transformation must have the capacity to  
37 analyze the associated changes of intra-organizational roles and relationships. This is needed to  
38 understand the impact of these changes on organizational structures and the way to embrace them  
39 through the transformation toward more networked forms of organization. Such firms must take care  
40 not to disrupt informal roles and relationships for support and advice about digital technologies, but  
41 rather seize the opportunity to align them with the existing organizational structure through a new  
42 definition of relationships, roles, and responsibilities through either organizational structure change or  
43 integration (Cross and Parker, 2004). Thus, the authors addressed the following main research  
44 question: What is the impact of digital transformation on large architecture and engineering firms'  
45 organization? And particularly on the interplay between formal and informal organizational structures?  
46 Based on this, the following corresponding objectives have been identified:

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- 1) To identify what roles and relationships informally play within large A/E firms due to the adoption of digital technologies;
  - 2) To understand how such roles and relationships operate;
  - 3) To analyze their interplay with formal roles and relationships.

Therefore, the overarching aim is to understand the impact of digital technologies adoption on the forms of organization of large architecture and engineering firms. This includes understanding the changes of intra-organizational roles and relationships due to digital technologies adoption, the impact

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of these changes on organizational structures, and particularly on the interplay between formal and informal structures.

Engineering, Construction and Architectural Management

## 2. Impact of digital technologies on organizational structures

There are diverse but interrelated organizational impacts that are associated with the adoption of digital technologies (Smits et al., 2017; Poirier et al., 2017). However, A/E firms sometimes just promote changes in ICT, without considering the need for aligning accordingly also people, structure, processes, and culture (Tulenheimo, 2015). In this way, firms may not undertake a digital transformation, but rather just implement a digital add-on. By doing so, they overlook the substantial differences between a) traditional digitally-enhanced work settings and b) innovative digitally-enabled work environments. This misunderstanding occurs when firms overlay digital knowledge and skills on top of traditional organizational structures. Additionally, firms can end up doing a fruitless investment in terms of productivity and competitiveness targets if they do not change their traditional forms of organization (García de Soto et al., 2018). Additionally, we agree with Ramilo and Bin Embi (2014) who argue that digital transformation is not just an evolution, like the one brought by computer-aided-design (CAD) technologies for example, but rather a disruptive process that creates a demand for new forms of organization. Liao and Ai Lin Teo (2018) also advocate a holistic view that recognizes the interdependence of organizational technologies and structures to undertake a digital transformation.

Therefore, the need for new forms of organization must be understood within a broader perspective. Digital transformation, in fact, has impacts on four constituting elements, which mainly define both the strategic and operational contexts of A/E firms. These elements can be categorized as 1) processes, 2) people, 3) products (in terms of software and tools), and 4) policies (Bonanomi, 2019). This knowledge construct can be used as a theoretical lens to understand and manage all the aspects being affected while undertaking a digital transformation. Hence, because of the multidimensional impacts of digital transformation, it can be argued that the adoption of digital technologies creates a demand for managing organizations as relational ecosystems "...or a group of interconnected elements, formed by the interaction of a community of organisms with their environment" (Laney, 2018; Zou, 2009). Some meaningful keywords can be underlined in this definition, namely: 1) interconnected elements, 2) interaction, and 3) community. If we compare these keywords with the ones typically used to describe conventional processes and practices - 1) silos, 2) transaction, and 3) individuality (e.g. Fulford and Standing, 2014) - the scale of the digital transformation paradigm shift can be made clear. In other words, digital technologies are disruptively changing the way professionals get their work done, how they relate to each other, and the way they set their working context (Bonanomi, 2019). Therefore, to grasp the full benefits from the adoption of digital technologies, firms should shift from a "work for me" approach - mainly based on static-hierarchical transactions - towards a "work with me" approach, made up by dynamic-networked interactions (Kiron et al., 2016). The above paradigm shift associated with the "businesses as digital ecosystems" metaphor creates a demand for firms to (re)think their organizational structure in such a way they can foster a more dynamic networked ecosystem (Roswell-Jones et al., 2017).

## 3. Formal and informal structures and their interplay

Monteiro et al. (2016) argue that today's organizations are under pressure from the external changing environment, particularly in terms of increasing complexity and competition in the industry. This pressure demands large-scale performance improvement and innovation in the way organizations are set-up to deliver their products and services. Additionally, Kotnour (2011) states that organizations need to transform when something outside or within their environment makes their business performance no longer acceptable. At the time this trigger event occurs, organizations' current business models become "irrelevant, unresponsive, and unready." In other words, they are no longer producing the right product in the right way. Lavikka et al. (2018) argue that the adoption of digital

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3 technologies represents this kind of trigger events that show the potential to affect the traditional forms  
4 of organization of the architecture and engineering industry. Accordingly, Porter and Heppelmann  
5 (2014) highlight that digital technologies have the necessary disruptive power to transform  
6 conventional organizational structures, typically designed as vertical hierarchies.

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8 Organizational structures determine how roles and responsibilities are assigned and thus how  
9 different management levels share information and make decisions (Jones, 2013). Hence, they draw the  
10 set of formal roles, relationships, and responsibilities (Robbins and Coulter, 2007). However, many  
11 researchers have shown that organizational structures have both a formal and informal nature (Soda  
12 and Zaheer, 2012; Wang et al., 2018). Regarding the origin of informal organizational structures,  
13 Wenger and Snyder, (2000) argue that they emerge in response to changes originating either outside or  
14 inside the organizational environment. Nickerson and Zenger (2002) point out that one motivation  
15 why informal organizational structures emerge is the inability of the formal structures to deal with  
16 specific issues. Therefore, the informal organization acts to overcome the constraints and limitations  
17 of the formal one. Soda and Zaheer (2012) specifically focus on understanding better such interplay  
18 between formal and informal structures by studying how they interact and the extent to which they  
19 complement or supplement each other to influence business performance. The findings of their study  
20 show the benefits of what they call the 'network consistency' - the alignment between formal and  
21 informal structure - in terms of business performance. A similar viewpoint is the one argued in the  
22 study by Wang et al. (2018) about the interplay between formal and informal institutions in projects.  
23 Their findings reveal that performance is better when there is a better fit—which indicates the extent of  
24 interplay—between a project's formal and informal organizational structure. Past research also shows  
25 that an informal organization left to their own design and not aligned with the formal one will operate  
26 in ways that are suboptimal - even dysfunctional - for the firm (Krackhardt and Stern, 1988).

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28 Regarding the management of informal structures and particularly to the extent of facilitating  
29 their alignment with the formal ones, Cross and Parker (2004) underline the importance of making  
30 such informal organizations transparent. They argue that most of the effort to promote efficient and  
31 effective organizational structures fail because managers overlook the informal roles and relationships  
32 of their employees. Most managers have little understanding of what informal role their employees  
33 play for other peers and about how their employees actually interact to get their daily work done.  
34 Consequently, managers may fail to understand the "hidden power of social networks" that can truly  
35 enhance or inhibit business performance (Cross and Parker, 2004). In line with this view, Cross et al.  
36 (2013) underline how business performance is not just a function of capable people and superior  
37 practices and processes, but also the product of relationships, both formal and informal.

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39 Hence, given the primary role played by both formal and informal organizational structures, as  
40 well as by their interplay, it is strategic to make informal structures transparent (Cross and Parker,  
41 2004; Whelan et al., 2011) and to align them with the formal ones (Soda and Zaheer, 2012; Wang et  
42 al., 2018). The above point is especially important for large A/E firms that need to shift to new forms  
43 of organization in order to grasp the full benefits from the adoption of digital technologies  
44 (Papadonikolaki et al., 2019). In the case of large firms, the formal organization might require  
45 employees to make too many steps throughout the formal structure to get in touch with the digital  
46 knowledge provider they need. Hence, the formal structure does not always facilitate employees to  
47 connect with the digital knowledge provider they need in an efficient and effective way. This is  
48 especially true during periods of digital transformation when required knowledge and skills are  
49 changing. In the same way, employees' need for creating informal relationships might also be  
50 necessitated by ineffective reporting to supervisors who are not familiar with digital technologies  
51 (Lines et al., 2015).

#### 4. Organizational structures as formal and informal networks

Despite the above implications, navigating organizational structure change during periods of digital transformation is difficult. Current theory emphasizes the importance of investigating the new forms of organization associated with digital transformation and understanding how they can be designed and managed (Papadonikolaki et al., 2019). However, little scholarship explains how firms can react and respond to this organizational structure change in practice. Scholarly work has noted the need for studying the features of the new forms of organization, and, for this purpose, research has started to explore the power of network theory particularly for designing and managing project organization (Chinowsky and Taylor, 2012; Pryke, 2012; Zheng et al., 2016).

However, to the authors' knowledge, little research has employed network theory as a lens for understanding and managing the new forms of firm organization. Very little is known about how intra-organizational roles and relationships change due to the adoption of digital technologies and about the impact of these changes on firms' organizational structures, both formal and informal. Additionally, most research has focused on these two structures independently and has not fully understood their interplay (Wang et al., 2018; Cross and Sproull, 2004). Lastly, research on designing and managing firm organization has been hindered by the absence of effective quantitative methods for analyzing both these structures, as well as their interplay. These considerations motivate our analysis of both formal and informal organizational structures, and of the interplay between these two particularly, through a social network analysis approach. To the authors' knowledge, Table I below includes all previous studies in the field closely related to the topic. It shows that little research has been focusing on the power of network theory for establishing and managing the new forms of firm organization associated with digital transformation. Even fewer research investigates the topic from the perspective of the interplay between the formal and informal organization as a means to achieve a holistic view of organizational functioning.

| Authors and publication date | Title   | Perspectives         |   |                                 |
|------------------------------|---|----------------------|---|---------------------------------|
|                              |   | Type of organization | Organization components analyzed                          | Methodological instruments used |
| Wang et al. (2018)           | The Interplay Between Formal and Informal Institutions in Projects: A Social Network Analysis       | Project organization | Interplay between formal & informal project organizations | Social Network Analysis         |
| Poleacovschi et al. (2017)   | The link between knowledge sharing connections and employee time savings: A social network analysis | Firm organization    | Formal and informal firm organization                     | Social Network Analysis         |
| Wanberg et al. (2017)        | Mechanisms to Initiate Knowledge-Sharing Connections in Communities of Practice                     | Firm organization    | Formal and informal firm organization                     | Social Network Analysis         |
| Schröpfer et al. (2017)      | Mapping the knowledge flow in sustainable construction project teams                                | Project organization | Formal project organization                               | Social Network Analysis         |

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|                               |  | using social network analysis |   |  |  |
| Matinheikki et al. (2016)     | Managing inter-organizational networks for value creation in the frontend of projects  | Project organization          | Formal project organization                                 | Semi-structured interviews                     |  |
| Keikotlhaile et al. (2015)    | Formalising the informal? Finding a balance between formal teams and communities of practice in a project-based organisation   | Project organization          | Interplay between formal and informal project organizations | Interviews, observation, and document analysis |  |
| Wanberg et al. (2015)         | The effects of organizational divisions on knowledge-sharing networks in multi-lateral communities of practice                 | Firm organization             | Formal and informal firm organization                       | Statistical resampling technique               |  |
| Soda G. and Zaheer, A. (2012) | A Network Perspective on Organizational Architecture: Performance Effects of the Interplay of Formal and Informal Organization | Firm organization             | Interplay between formal and informal firm organizations    | Semi-structured interviews and surveys         |  |
| Javernick-Will (2011)         | Knowledge-sharing connections across geographical boundaries in global intrafirm networks                                      | Firm organization             | Formal firm organization                                    | Social Network Analysis                        |  |
| Kratzer et al. (2008)         | Balancing creativity and time efficiency in multi-team R&D projects: The alignment of formal and informal networks             | Project organization          | Interplay between formal and informal project organizations | Semi-structured interviews and surveys         |  |

Table I: Studies providing a picture of similar attempts available in the literature

To address this gap, this study seeks to understand the impact of digital transformation on large architecture and engineering firms' organization and particularly on the interplay between formal and informal organizational structures. To dive deeper into this scope, the following sub-questions are addressed:

1. What roles and relationships informally play within large A/E firms undertaking digital transformation?
2. How do such roles and relationships operate?
3. What is the interplay of these informal roles and relationships with the formal ones?



#### 4. Research approach

A *case study* approach was used to address the main question and sub-questions proposed in this research. A case study approach fits well in the study of firms' organization from a network perspectivesince it facilitatesadeep exploration of all the 'how' and 'why' questions (Yin, 1994) about network relationships and roles.Hence, we performed an in-depth case study exploration of the changes of roles and relationships within a large A/E firm due to the adoption of digital technologies, and the related impact on the organizational structure, without isolating it from its context (Bryman, 2008). Furthermore, research shows that a case study approach can adopt both quantitative and qualitative methods. It has been argued that qualitative research methods work better in capturing the complexity of the AEC industry. However, due to the complex dynamic network of roles and relationships, which characterizes project-based organizations (Pryke, 2017), such as large A/E firms undertaking digital transformation, a mixed-method approach was adopted. Hence, the data collected during this study is a combination of qualitative and quantitative data.Furthermore, this research approach must be understood as *participatory* in nature. Thanks to a five-month close interaction with the firm selected as case-study, the first author conducted interviews, analysis, regular check-ins, and interpretation of findings on a weekly basis and in continuous dialogue with middle and top management, in particular with the firm's knowledge strategy manager.

##### 4.1 Case study selection

The research was conducted in close collaboration and interaction with Stantec, a large A/E firm headquartered in Edmonton, Canada. Stantec is one of Canada's leading architecture and engineering groups, with around 23,000 employees globally distributed in around 300 locations. The firm is organized into five business operating units (BOUs): 1) Environmental Services, 2) Infrastructure, 3) Water, 4) Energy & Resources, and 5) Buildings. The 'Energy & Resources' BOU is further subdivided into four business lines (BLs): Power, Mining, Oil & Gas, and Waterpower & Dams. In the same way, the 'Infrastructure' BOU is divided into two business lines: Community Development and Transportation. Hence, in total, Stantec is organized into five BOUs and eleven BLs, if one considers 'Corporate' as a business line. Each of the five BOUs works across different regions and each of them includes diverse business centers (BCs) organized into office locations (see Fig. 1).

At the time of the five-month collaboration (from May 2017 to September 2017), the digital business transformation at Stantec had already been ongoing for three years. To make an example, all five BOUs – led by the 'Buildings' BOU – had begun developing BIM competencies. In addition, each BOU received access to virtual reality, augmented reality and mobile app development through the internal program "Creativity and Innovation." In 2017, senior leaders began holding conversations about formalizing a specific business service aimed at facilitating advice and information exchange about digital technologies and at enhancing the digital business transformation. To integrate this new service, an internal investigation began in order to understand how advice and information exchange about digital technologies was operating within Stantec.

Stantec represented an excellent research setting to understand the impact of digital technologies adoption on large A/E firms' organizational structures through the analysis of how roles and relationships change.

## 4.2 Methodology

An analysis of both the formal and informal organizational structure, and of the interplay between these two, was performed in close cooperation with Stantec to extract the data found in this paper. Throughout the data collection, the first author conducted interviews, analysis, regular check-ins, and interpretation of findings in dialogue with middle and top management. Based on this, we could depict the formal reporting structure, the informal structure for advice and information exchange about digital technologies, and the interplay between these two. This allowed for emergent discussion of the challenges facing the firm and identified future opportunities for improvement. Stantec participated in the research with the intended purpose to identify organizational change strategies that will better position the firm's structure in a more digital future.

Insert Figure 1 here

### 4.2.1 Identifying the formal structure

To identify the formal reporting structure of Stantec, we gathered data in the form of spreadsheets listing all the organizational parent-children couples - in other words, the dyadic supervisor-employee connections - from the human resources (HR) database. In total, the HR spreadsheets reported the direct reporting relationships for 22,769 employees. From the gathered spreadsheets, we performed a document analysis by using a Matlab® custom script to build the firm's authority chains organized by levels of management. The resulting dataset was loaded into RAWGraphs®, an open-source data visualization framework, to automatically generate a cluster dendrogram displaying the firm's authority chains. This visualization illustrates the formal reporting structure of Stantec. Yet, this dendrogram was not dynamic and searchable, so another interactive map was programmed using the D3 Javascript® library (see Fig. 2) and loading the same input data obtained through the Matlab® custom script. The resulting visualization allowed searches for individual employees and would return a highlighted reporting chain (see Fig. 2). Lastly, we transformed such reporting chains into networks. The result is an authority network map transforming reporting relationships into directed ties between network nodes. That map visualizes all Stantec personnel colored by BOUs and organized into sub-network hubs according to their formal reporting relationships (see Fig. 3). In this way, we could bring both the formal and informal structures down to a common denominator, which is the network perspective, since the formal structure represents a pattern of resource flows just as the informal structure does.

### 4.2.2 Identifying the informal structure

To identify the informal structure for advice and information exchange about digital technologies, we adopted the methodology of social network analysis. Social network analysis is a people-analytics method, adapted from Social Sciences, which can help to understand formal and informal organizational connections and knowledge flows (Schröpfer et al., 2017). SNA has been shown to be an effective and emerging tool in engineering research that uses systems theory to describe how relationships influence behaviors (Chinowsky et al. 2008; Zheng et al. 2016). Recently, SNA has been used as both a qualitative and quantitative foundation to analyze the dynamic properties of construction projects (Chinowsky and Taylor, 2012). For the purpose of this study, SNA was employed as an investigation tool a) to identify what roles and relationships informally played within the firm due to the adoption of digital technologies; b) to understand how such roles and relationships operated; c) and to analyze their interplay with the formal ones as defined by the formal reporting structure. SNA also acted as a decision-making support tool, which will be discussed later in the paper (see Section 6).

To achieve this, we gathered social network data at the individual level through two rounds of internal surveys delivered through KeySurvey®, an online survey software and questionnaire tool. Research shows that surveys are the most appropriate tool to collect social network data (Wasserman and Faust, 2009). Particularly, we adopted a snowball sampling method (Biernacki & Waldorf, 1981), meaning that people in the first round identified others that the survey went to in the second round. We started with the practice technology advisory committee, which was one representative from each of the five BOUs, by asking them who they knew of who worked in the digital technologies ‘universe’, and that was used to generate our first list. This ended being a list of 111 people. From this list, we delivered a survey, which asks respondents to select other peers (up to 15 people) acting as sources of advice and information about digital technologies from a predefined list of names. In this first round, we had 57 respondents (response rate of 51%), who identified 445 connections, and when we removed the duplicates of people we already knew about, we got a cumulative total of 409 people working in the digital technologies universe. After this, the next round of the survey went to everyone we already knew about (409), minus people who had already taken the survey (57). So the next round was sent to 352 people. One-hundred eighty-nine employees representing 108 different offices responded to the survey (response rate of 54%) and reported 949 connections. When we removed the people we already knew about, we had a total of 513 people.

The SNA questionnaire had two categories of questions. First, respondents were asked to identify other peers to whom they go for advice and information about digital technologies. Second, respondents were asked questions regarding their current office location and business line. The respondent answering the survey is referred to as the ‘ego’ and the connections that egos report are referred to as ‘alters’ (Javernick-Will, 2011). Other basic network terms used in this study are defined in Table II. ‘Egos’, or the employees responding to the survey, reported 949 digital-knowledge sharing connections across a network of 513 professionals from 141 offices. This network included both the ‘egos’ and ‘alters’, or people who did not respond directly to the questionnaire but to whom ‘egos’ reported connections for advice and information exchange about digital technologies with.

Data collected from the SNA survey were used to identify those employees playing an informal role, outside of their formal one, as providers of advice and information about digital technologies to other peers. The same data were also used to understand the informal relationships pattern of these employees by using Kumu®, a data visualization platform. Kumu® helps to organize complex datasets into interactive relationship maps through graphical representations. This phase of analysis resulted in the development of a sociogram displaying the informal organizational structure for advice and information exchange about digital technologies (see Fig. 4).

Insert Table II here

#### 4.2.3 *Identifying the interplay of formal and informal structures*

To identify the interplay between the formal and informal structure of Stantec, we developed a map visualizing the informal sources of advice and information about digital technologies as network nodes and their formal direct reporting relationships (supervisor-employee) as network links (see Fig. 5). Specifically, we associated each of the 513 employees identified as informal ‘go-to’ people for advice and information about digital technologies with their formal supervisors. In this way, we created a network map - using only these informal ‘go-to’ people - and using the same process as the network map displaying the formal reporting structure of Stantec (see Fig. 5). This new network map shows clusters where informal ‘go-to’ people are networked to one another through their formal direct reporting relationships with their supervisors.

The purpose of analyzing the formal direct reporting relationships of those employees identified as informal sources of advice and information about digital technologies was to understand how the formal structure of Stantec performs in terms of supporting information and knowledge-sharing about digital technologies. Specifically, we aimed at understanding if the firm's reporting structure facilitates such informal 'go-to' people to directly connect to one another and therefore to share information and knowledge about digital technologies.

## 5. Findings

### 5.1 *The formal reporting structure*

As mentioned above, we created two different maps about the formal reporting structure, namely a cluster dendrogram (see Fig. 2) and a network map (see Fig. 3). On one side, the cluster dendrogram displays the firm's authority chains in the form of a tree chart. This visualization reveals that Stantec personnel is organized into twelve management levels according to a hierarchical pattern (see Fig. 2). On the other side, the network map visualizes all the Stantec personnel colored by BOUs and connected by network links according to their direct reporting relationships (see Fig. 3). It identifies Stantec personnel (network nodes) and their formal reporting relationships (network links) grouped together into subnetwork hubs according to their management structure. Visual inspection reveals that the network nodes mostly cluster with similar nodes of the same color. This represents clusters of employees formally grouped together in the same BOU. As displayed in the map legend (see Fig. 3), each color represents one of the five business operating units.

Insert Figure 2 here

As mentioned above, the visual analysis of the network map displaying Stantec's formal structure (see Fig. 3) finds how connections occur mainly between people of the same BOU. This means that formal relationships are mainly designed according to employees' expertise in a specific functional area. This type of organizational structure can be described as a functional hierarchy. Functional hierarchies are typically not designed to facilitate connections between employees working in different business units or departments. On the contrary, this type of organizational structure enables mainly functional relationships. While such an organizational pattern strengthens functional competency, it does not facilitate cross-functional interactions and transdisciplinary knowledge-sharing, which are increasingly important when undertaking a digital transformation.

Insert Figure 3 here

### 5.2 *The informal structure for advice and information exchange about digital technologies*

Data gathered through the two rounds of surveys allowed to identify the informal structure for advice and information exchange about digital technologies operating within Stantec (see Fig. 4). From the gathered network data, we identified 513 employees from 141 offices who play an informal role as sources of advice and information about digital technologies for other peers. The visualization depicted in Figure 4 reveals that such employees exchange advice and information about digital technologies through networked relationships. Hence, they are organized according to a networked pattern.

The visual analysis of the network map reveals that overall such 513 professionals are well connected to one another. Specifically, 90% of these professionals show high degree centrality and only 11% of them (61 elements) are marginalized and disconnected from the other peers. As described

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3 by Table III below, the 513 members of this informal network work within all the five business  
4 operating units. The 513 nodes of the network map (see Fig. 4), in fact, are colored differently  
5 accordingly to the 5 diverse BOUs. Particularly, most of the members of this informal network are  
6 formally associated with the 'Buildings' BOU (157 network nodes/ 31% of the total / colored in  
7 orange).

8  
9 Unlike the network map of the formal organizational structure of Stantec that displays mainly  
10 functional relationships (see Figure 3), the visual analysis of this network graph reveals also cross-  
11 functional connections (see Figure 4). The network nodes, in fact, are not colored homogeneously.  
12 Furthermore, the network map below shows the presence of corporate personnel, as well as people  
13 working in the functional services team (94 network nodes colored in grey).

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17 Insert Table III here

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21 Insert Figure 4 here

### 22 *5.3 The interplay between formal and informal structure*

23 After having identified the informal go-to people for advice and information about digital technologies  
24 and their informal relationships' pattern (see Fig. 4), we also investigated the formal relationships that  
25 the reporting structure builds between these professionals (see Fig. 5). This analysis finds that only  
26 35% of them can formally connect one another thanks to the direct reporting relationships that the  
27 formal structure builds between them. As shown in the map below (see Fig. 5), these professionals,  
28 who are formally connected one another through formal direct reporting relationships, represent a  
29 small part of the whole. They are mainly located at the top right of the graph and organized in ten  
30 subnetwork hubs. The remaining 65% nodes are formally disconnected and scattered around without  
31 any links connecting one another.

32  
33 Furthermore, nodes are (dis)organized into a quite sparse and fragmented pattern, with little  
34 resemblance of an interconnected network (see Fig.5). The informal go-to people for advice and  
35 information exchange about digital technologies at Stantec are informally well connected (see Fig. 4),  
36 but formally quite disconnected from one another (see Fig. 5). This means that the formal structure and  
37 does not help employees performing similar digital tasks and with analogous digital knowledge and  
38 skills to easily get in touch. On the contrary, these professionals, who are referenced by other peers as  
39 informal sources for advice and information about digital technologies, are formally isolated one from  
40 another (see Fig. 5). It is likely that this formal disintegration means that Stantec can miss  
41 opportunities for such informal digital advice and information sources to formally contribute to digital  
42 knowledge creation, communication, distribution and/or innovation.

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48 Insert Figure 5 here

### 49 *5.4 Summary of findings*

50  
51 To briefly summarize, our research findings reveals that a) the formal structure of Stantec is a  
52 hierarchy framed into twelve levels of management and organized in functional teams, b) some  
53 employees play an informal role, outside of their formal one, as sources of advice and information  
54 about digital technologies for other peers, c) such employees operate through networked and cross-  
55 functional relationships, d) hence, an informal structure operates within the firm as a social network  
56 for advice and information exchange about digital technologies, and e) regarding the interplay of such  
57 informal structure with the formal one, there is a lack of alignment between these two.  
58  
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## 6. Discussion

The analysis of the interplay between the formal and informal structure of Stantec indicates that there is a lack of alignment between these two. In other words, the formal direct reporting relationships do not overlap with the informal supporting connections for advice and information exchange about digital technologies. Therefore, Stantec demonstrates a low level of network consistency – i.e. little overlap between informal and formal structures. To the contrary, high levels of network consistency have been found to have a positive effect on business performance (Soda and Zaheer, 2012). Because network transparency and consistency between informal and formal structures can boost performance and productivity (Cross and Parker, 2004; Soda and Zaheer, 2012), formally acknowledging these two structures is important within A/E firms undertaking digital transformation. Also, making transparent and consistent these informal structures can help firms to mitigate the flight risk of those professionals who are dissatisfied for not being formally recognized as digital knowledge-providers. One strategy can be, for example, formally creating a digital experts' team, available across the diverse business units, lines, and office locations, to employ the collective knowledge and skills about digital technologies.

### 6.1 Formal and informal structures in periods of digital transformation

When mapping all the connections in play within firms facing digital transformation, it should not be surprising to identify both formal reporting relationships and informal supporting connections for advice and information exchange about digital technologies.

In periods of digital transformation, the Stantec case demonstrates that the formal reporting structure might not help to directly connect the right people. In other words, authority chains are not always providing employees with an efficient and effective path for connecting with the digital knowledge providers they are seeking. On one side, employees often report to supervisors who are not familiar with digital technologies; on the other side, the formal organization might require employees to make too many steps throughout the reporting structure to get in touch with the digital knowledge provider they need. Therefore, employees start seeking for advice and information about digital technologies outside of the formal reporting structure by connecting with peers, who are not formally acknowledged for that role. This translates into the creation of new informal leaders. One explanation for the creation of an informal structure is the internal change in the knowledge and skills required for workers to get their job done due to the adoption of digital technologies. Additionally, market pressure is an external factor, which contributes to the rise of this informal structure.

This condition results in the creation of new roles and relationships building an informal network for advice and information exchange about digital technologies. This study argues that such informal structures must be made transparent and aligned with the formal structures to facilitate an integrated knowledge management associated with digital technologies.

### 6.2 Risks of overlooking informal structures

If left alone, informal structures, such as the one for advice and information exchange about digital technologies operating within Stantec, tend to lack transparency and alignment with the formal ones. This condition can lead to a lower level of contribution of such informal structures to organizational knowledge management (Cross and Parker, 2004; Krackhardt and Stern, 1988). As emerged in conversations with middle and top management of Stantec, there can be long term risks associated with the overlooking of informal structures for advice and information exchange about digital technologies.

- 1) *Risk of overload.* When overlooking the informal roles that may operate within A/E firms undertaking digital transformation, firms risk those employees playing such informal roles, beyond their formal ones, being overloaded. These professionals- to whom employees start

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3 referring - can end up having too many links with other peers because their advice and  
4 knowledge about digital technologies are so crucial. In some cases, they can even end up being  
5 overwhelmed with demands and run the risk of slowing down their performance and  
6 productivity.

- 7  
8 2) *Risk of flight*. The overlooking of such informal advice and information-exchange networks for  
9 digital technologies can also represent an issue in terms of flight risk. The informal 'go-to'  
10 people for digital knowledge, who are dissatisfied by not getting the appropriate recognition for  
11 the work done, are most likely prepared to accept a working proposal from another company.  
12 In support of this statement, it could be argued that Stantec has been struggling to retain digital  
13 experts' staff.
- 14  
15 3) *Risk of knowledge loss*. These informal digital knowledge sources, who are usually well  
16 connected to knowledge sources outside the firm (i.e. users' groups, blogs, conferences,  
17 innovation labs, etc.), must possess strong connections internally as well. If the formal structure  
18 does not facilitate relationships between these professionals, there is the risk of losing  
19 opportunities for digital knowledge creation, sharing, and innovation. An effective and  
20 efficient digital knowledge management occurs when both the reporting and supporting  
21 relationships are transparent and aligned. Without an effective knowledge distribution network,  
22 the contributions of such digital knowledge sources to digital transformation are limited and  
23 hampered by the lack of a formal role, thus authority and responsibility.

### 24 25 26 27 28 6.3 SNA as a decision support tool for organizational change

29 At the beginning of the research collaboration, there was little awareness of the informal roles and  
30 relationships for advice and information exchange operating within Stantec. However, some senior  
31 managers had a visionary understanding of such informal structure and of the competitive advantage  
32 that could have arisen from making it transparent and aligned with the formal one.

33 Given the above considerations, the purpose of employing social network analysis (SNA) in  
34 this study was two-fold: on one side, as an investigation tool, on the other side, as a decision support  
35 tool. While the use of SNA as an investigation tool aims at identifying and analyzing informal  
36 structures, its employment for supporting decisions aims at informing organizational structure change.

37 A typical common goal of organizational (re)design is bringing together employees who  
38 perform related tasks while being dispersed in different business lines, as in the firm case study that we  
39 analyzed. Hence, the proposal of Stantec of a new corporate group for digital technologies aims at  
40 bringing together the informal digital knowledge sources for supporting the firm's digital  
41 transformation. The presence in the informal network for digital technologies of many professionals  
42 from the 'Corporate' BOU - 18% of the entire network - demonstrates the strategic role that such  
43 network should also play at the corporate level, not only related to specific business lines or office  
44 locations. A corporate support group for digital technologies could help in directly bridging providers  
45 and seekers of digital knowledge, therefore reducing the number of steps required for any employee to  
46 get in touch with the needed digital knowledge source. Furthermore, bringing together people who are  
47 doing similar work, but who are currently not connected, would also help to achieve economies of  
48 scale while sharing best practices and expertise across the organization. At the practice level, we argue  
49 that using social network analysis can support decisions about the organizational structure change or  
50 integration, which is required for making transparent and formally acknowledged such informal  
51 structures.

## 7. Implications

This study demonstrates the potential for researchers to combine theories and methods coming from organizational design, change management, and knowledge management by applying a network perspective in the context of the digital transformation of large A/E firms. As demonstrated by the Stanteccase, researchers can use tools, such as SNA, to investigate formal and informal structures, and their interplay particularly, within firms undertaking digital transformations. The implications of a lack of transparency of the informal advice and information exchange networks for digital technologies and of their lack of alignment with the formal structures awaits for further scholarly exploration.

Our article also makes significant managerial contributions. Using the analytical approach proposed in this work, A/E firms' managers could evaluate the effectiveness and efficiency of the existing reporting structure in terms of digital knowledge management by analyzing the interplay between formal and informal structures. If identified a lack of transparency of the informal advice and information exchange network for digital technologies and a lack of alignment with the formal structure, top management could intervene. On one side, managers could investigate the formal structure to make sure that advice and information-exchange about digital technologies is both sufficient and efficient. If not, then absent or long-distance advice and information channels for digital technologies could be bridged through organizational structure change. On the other side, informal structures can be adjusted, for example, by promoting the sharing of experiences and know-how (Bresnen, Goussevskaia, & Swan, 2004). However, adjusting the informal structure to overcome shortcomings and inefficiencies associated with the formal structure is a potential area for future research.

This study also has significant methodological implications. One implication is the translation of firms' organization into social networks so that social network analysis can be applied to the study of firms' organizations, and not only of project organizations (Chinowsky and Taylor, 2012; Pryke, 2012; Zheng et al., 2016). Employing SNA in organizational studies enables the representation of firms' formal and informal networks through informative graphs and quantitative languages that can trigger further in-depth analyses. Unlike previous organizational design and management research, this study employs SNA to lead this investigation and show how the analysis and change of firms' organization can be described graphically, quantitatively analyzed, and longitudinally monitored.

## 8. Conclusions

This study builds upon the recent findings that digital technologies can deeply affect the forms of organization of the AEC industry (Papadonikolaki et al., 2019, Whyte, 2019). This study contributes to this research stream by addressing the impact on large A/E firms' organizations due to digital technologies adoption. Particularly, it investigates the informal roles and relationships that can emerge within A/E firms undertaking a digital transformation. So far, most research has focused on the new forms of project organization by adopting network theory as a lens for their design and management (Chinowsky and Taylor, 2012; Pryke, 2012; Zheng et al., 2016). However, much less research has studied the impact on firms' organization due to digital technologies adoption and employed of network theory to understand their design and management. Also, the literature about organization design and management acknowledges the importance of both *formal and informal* structures for understanding organizations and their performance (Soda and Zaheer, 2012). However, so far, most research has focused on these two structures independently and has not fully understood their *interplay* (Scott, 2013; Wang et al., 2018).

This research adopted a mixed-method case study approach by the way of combining interviews, regular check-ins, and document analysis with data mining and social network analysis to identify and analyze both the formal and informal structures of the selected case-study.



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3 Additionally, the interplay of these two structures was explored, as well as the implications of their  
4 lack of alignment. Regarding the formal structure of Stantec, the results indicate that a vertical  
5 hierarchy structured into twelve levels of management worksthrough functional teams. On the other  
6 side, data collection and analysis about the informal structure reveals that a cross-functional network  
7 for advice and information exchangeabout digital technologiesoperates within Stantec.  
8

9  
10 In order to enable the transparency of such informal networksand their alignmentwith formal  
11 structures, firms must facilitate an understanding of ‘who knows what’. Therefore, firms should  
12 identify informal sources of digital knowledge and their relationships’ pattern to ease this process. To  
13 this extent, we argue that social network analysis can be a valuable investigation tool. Furthermore, we  
14 claim that SNA can also support the decision-making about the organizational structure change or  
15 integration required for making transparent and formally acknowledging such informal advice and  
16 information exchange networks for digital technologies.  
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18  
19 This work was validated through the theoretical lens of organizational design, change  
20 management, and knowledge managementcombined together through a network perspectivein the  
21 context of the digital transformation of large architecture and engineering firms. The digital  
22 transformation of the A/E sector has the potential for radically transforming the way practitioners  
23 work and interact with one another. The adoption of digital technologies in A/E firms, in fact,  
24 candeeply affectorganizational relationships, and therefore roles and responsibilities. The opportunity  
25 that this may present is not just to redesign job structure, but to fundamentally rethink “organizational  
26 architecture”. To recognize and capture the full benefits associated with the adoption of digital  
27 technologies, A/E firms must undergo a deep business transformation by re-configuring their  
28 organizational structures. This transformation can take as a reference a business scenario  
29 whereintegrated processes are managed by a cross-functional network of teams and underpinned by  
30 digital technologies.  
31

32  
33 To gain the full benefits from digital technologies, an increasing number of researchers are  
34 stressing the importance of new forms of organization.In the conventional hierarchical structures,  
35 employees are highly departmentalized and information is transferred downstream in functional  
36 pipelines. In periods of digital transformation, this kind of organizational structure can create problems  
37 of knowledge-sharing, decision-making, and contribution to innovation. For example, professionals,  
38 who have similar digital knowledge and skillsbut workin different business lines or office locations,  
39 may not have formal opportunities fornetworking and being informed of the parallel activities going  
40 on. This condition can also lead tolosing the possibility of sharing experiences and know-how.Without  
41 a formal knowledge distribution network, the possibility for contributions of the firm’s digital  
42 knowledge sources to digital innovation limited. For such reasons, collaboration and integration  
43 invertical hierarchical organizations operating via functional teams can be hampered, thus turning  
44 digital knowledge creation, distribution, and innovation to be critical.  
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## 50 **9. Limitations and future directions**

51 Future research could address and overcome some limitations of this study. First, because of the single  
52 case study approach, the generalization of our findings will require more evidence about the changes  
53 of roles and relationships due to digital technologies adoption and about the impact of these changes  
54 on organizational structure, and particularly on the interplay between formal and informal structures.  
55 Additionally, generalizability is also limited because our results might be specific to the type of digital  
56 technologiesadopted in the case study.Second, while we studied informal networks for advice and  
57 information exchange about digital technologies, we were not able to perform an in-depth analysis of  
58 the mechanisms (i.e physical proximity, project involvement, etc.) through which such informal roles  
59 and relationships are created. Third, even though we captured the informal advice and information  
60

exchange network for digital technologies, we were not performing statistical analysis about the features of the network itself. Therefore, the statistical significance of this study's analysis is marginal, meaning that it is more appropriate to view our findings as indicative rather than decisive.

Given these limitations, future work can extend and generalize the findings by investigating the impact on organizational structures due to digital technologies adoption in additional large A/E firms. Furthermore, future research should consider the impact on firms' organization due to the adoption of other types of digital technologies and assess if different findings and trends are found. Also, future research may consider combining quantitative study through SNA and qualitative analysis via interviews in order to get the full picture of the features and the mechanisms acting behind such informal networks. Lastly, future research may also benefit from a second analysis phase to further investigate the complexity of such informal networks. For example, this could include the analysis of the influence on digital knowledge creation, sharing, and innovation of finer-grained attributes, such as the management level and the discipline of the network nodes.

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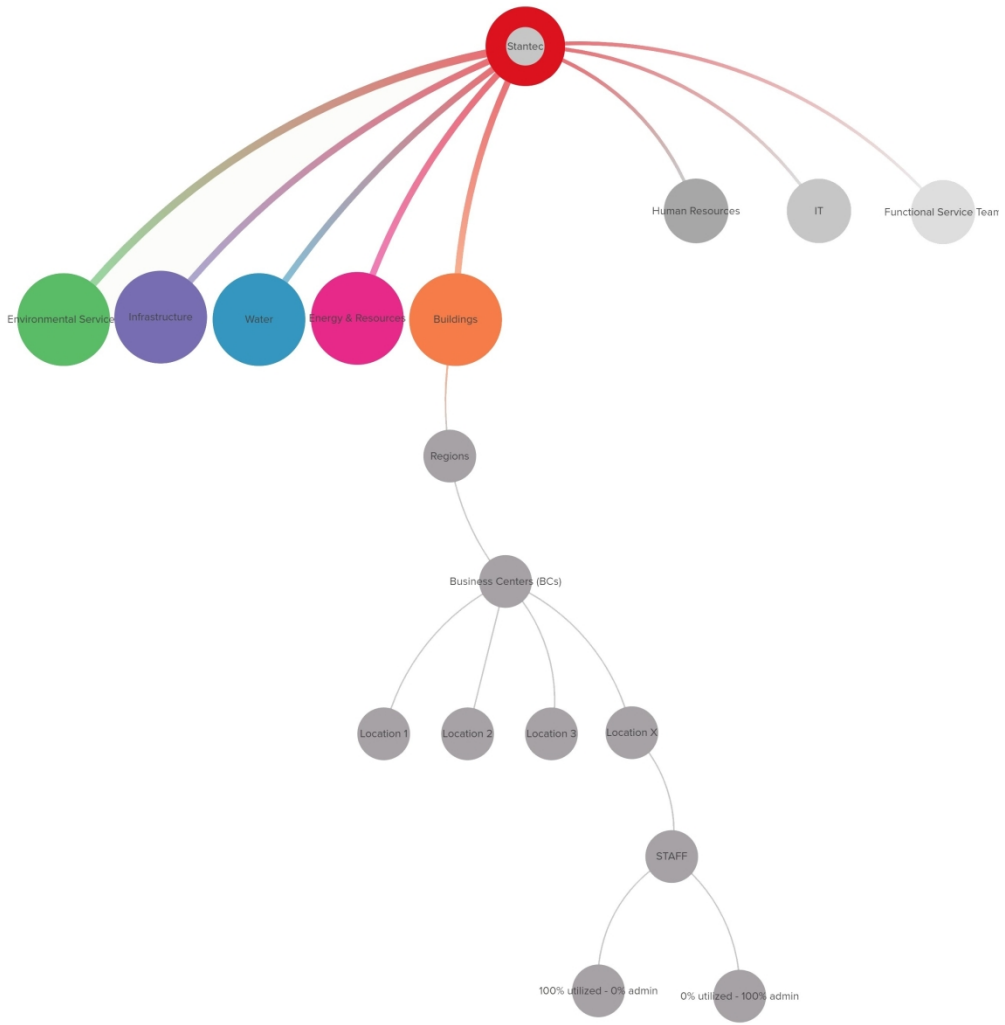


Figure 1 Stantec functional BOUs operating across regions, each of them organized into BCs working in different office locations

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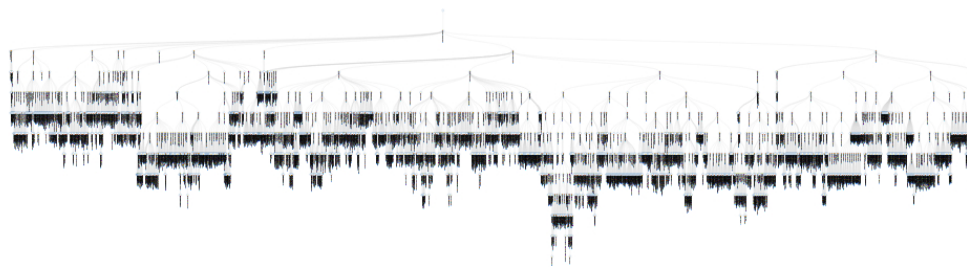


Figure 2 Dynamic and searchable dendrogram visualizing the formal organizational hierarchy. Example of a reporting chain, colored in red, obtained by searching for an employee's name

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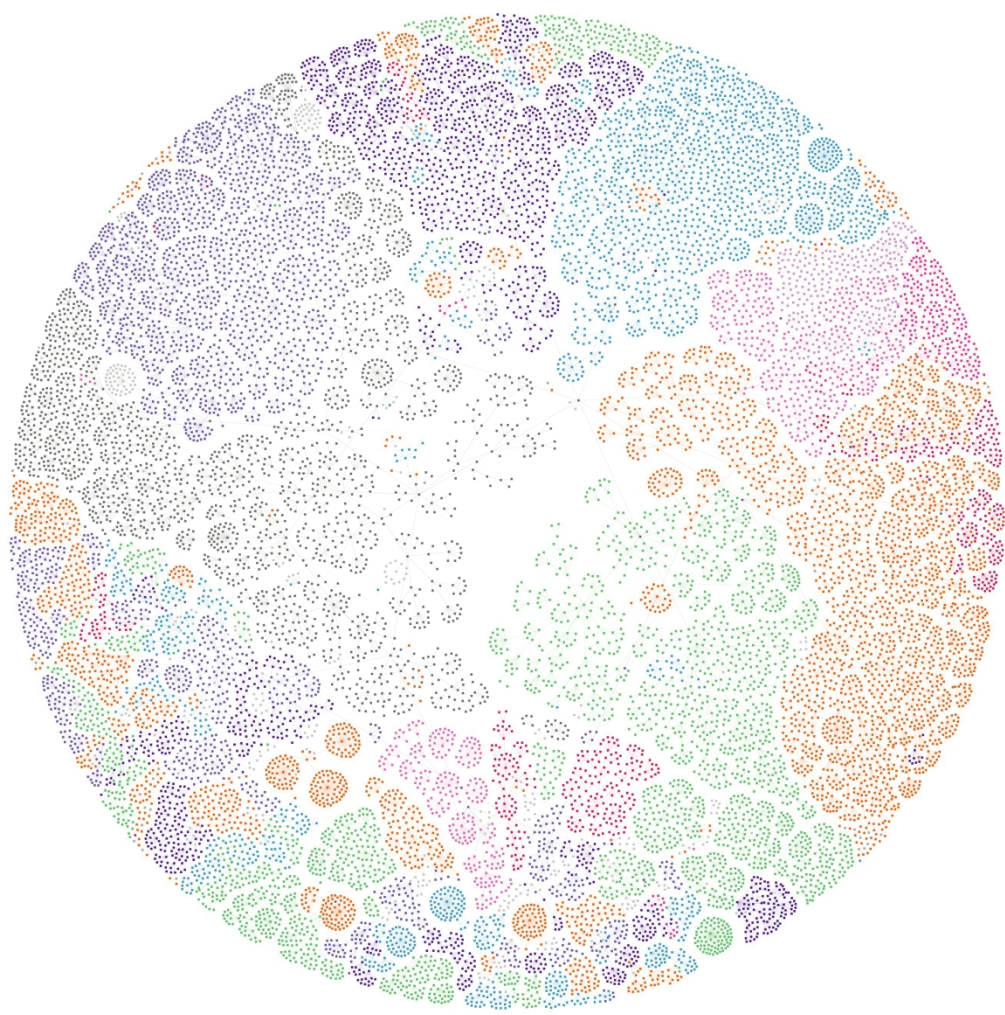


Figure 3 Network map visualizing Stantec employees colored by BOUs (network nodes) and connected to the related supervisor according to the formal reporting structure (network links)



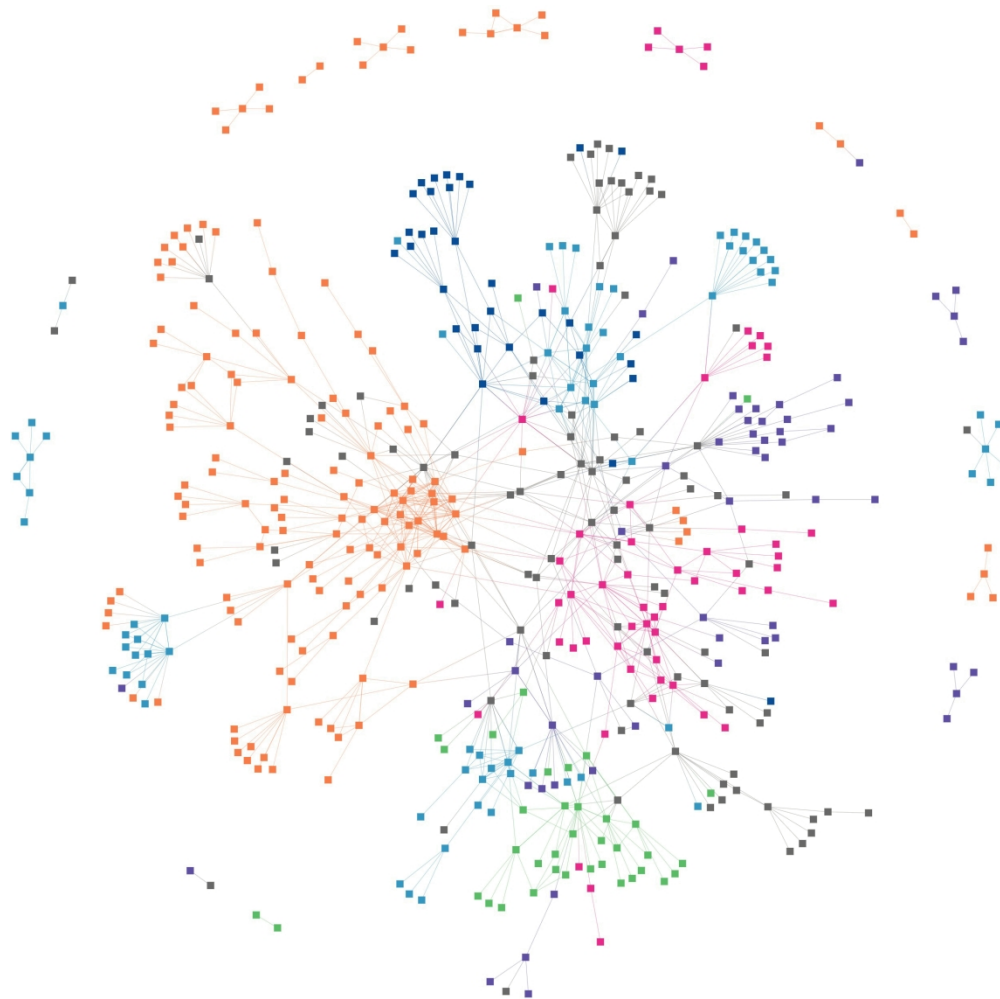


Figure 4 Network map visualizing employees (network nodes) identified by others as informal go-to people for digital knowledge and connected one to each other through informal relationships (network links). They are colored by BOUs.

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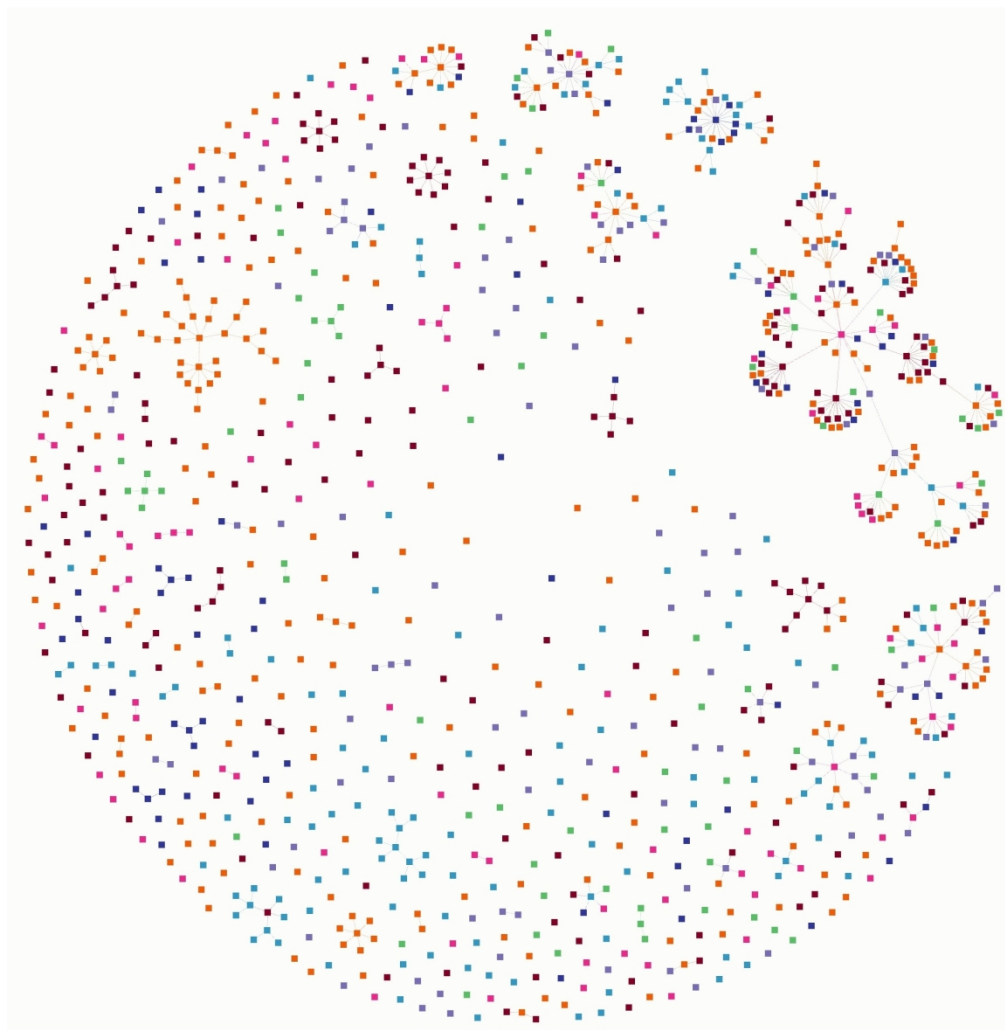


Figure 5 Network map visualizing the employees (network nodes) identified by others as the informal go-to people for digital knowledge and (dis)connected one to each other through formal relationships (network links). They are colored by BOUs.

669x690mm (96 x 96 DPI)

| Authors and publication date  | Title  | Perspectives         |   |  |
|-------------------------------|--|----------------------|---|--|
|                               |  | Type of organization | Organization components analyzed                            | Methodological instruments used                |
| Wang et al. (2018)            | The Interplay Between Formal and Informal Institutions in Projects: A Social Network Analysis                                  | Project organization | Interplay between formal & informal project organizations   | Social Network Analysis                        |
| Poleacovschi et al. (2017)    | The link between knowledge sharing connections and employee time savings: A social network analysis                            | Firm organization    | Formal and informal firm organization                       | Social Network Analysis                        |
| Wanberg et al. (2017)         | Mechanisms to Initiate Knowledge-Sharing Connections in Communities of Practice  | Firm organization    | Formal and informal firm organization                       | Social Network Analysis                        |
| Schröpfer et al. (2017)       | Mapping the knowledge flow in sustainable construction project teams using social network analysis                             | Project organization | Formal project organization                                 | Social Network Analysis                        |
| Matinheikki et al. (2016)     | Managing inter-organizational networks for value creation in the frontend of projects  | Project organization | Formal project organization                                 | Semi-structured interviews                     |
| Keikotlhaile et al. (2015)    | Formalising the informal? Finding a balance between formal teams and communities of practice in a project-based organisation   | Project organization | Interplay between formal and informal project organizations | Interviews, observation, and document analysis |
| Wanberg et al. (2015)         | The effects of organizational divisions on knowledge-sharing networks in multi-lateral communities of practice                 | Firm organization    | Formal and informal firm organization                       | Statistical resampling technique               |
| Soda G. and Zaheer, A. (2012) | A Network Perspective on Organizational Architecture: Performance Effects of the Interplay of Formal and Informal Organization | Firm organization    | Interplay between formal and informal firm organizations    | Semi-structured interviews and surveys         |
| Javernick-Will (2011)         | Knowledge-sharing connections across   | Firm organization    | Formal firm organization                                    | Social Network Analysis                        |

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|                       | geographical boundaries in global intrafirm networks   |                      |   |  |
| Kratzer et al. (2008) | Balancing creativity and time efficiency in multi-team R&D projects: The alignment of formal and informal networks | Project organization | Interplay between formal and informal project organizations | Semi-structured interviews and surveys |

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**Table I** Studies providing a picture of similar attempts available in the literature

| <b>Network term</b> | <b>Description</b>   |
|---------------------|--|
| Formal structure    | The formal structure of an organization includes those reporting relationships defined by hierarchy, business processes, and assigned teams, alias the leadership pattern put in place by the organizational management. |
| Informal structure  | The informal structure is made up of interpersonal connections not formally designed, nor engineered by the formal structure.  |
| Dendrogram          | A dendrogram is a tree graph that shows the hierarchical relationship between elements. It is commonly created as an output from hierarchical clustering.  |
| Sociogram           | A sociogram is a network graph that displays actors as nodes and the relational ties connecting actors as lines.   |
| Network node        | Nodes represent organizational players. In a sociogram, or network graph, they are linked one another by relational ties.  |
| Network link        | The links between the nodes represent relationships between the individuals, such as information exchange.   |

**Table II** Glossary of network terms

| <b>Business Operating Unit</b> | <b>N° of network members by BOU</b> | <b>% of network members by BOU</b> |
|--------------------------------|-------------------------------------|------------------------------------|
| Buildings                      | 157                                 | 31%                                |
| Corporate & Shared Services    | 94                                  | 18%                                |
| Infrastructure                 | 86                                  | 17%                                |
| Water                          | 83                                  | 16%                                |
| Energy & Resources             | 55                                  | 11%                                |
| Environmental Services         | 38                                  | 7%                                 |

**Table III** Informal network members classified by business operating units

| REVIEWER (1) COMMENT  | Pg. & line no. where the comment is addressed | DESCRIPTION OF HOW WE ADDRESSED THE COMMENT   |
|---|---|---|
| <b>ORIGINALITY</b>  |   |   |
| None  |   |   |
| <b>RELATIONSHIP TO LITERATURE</b>   |   |   |
| None  |   |   |
| <b>METHODOLOGY</b>  |   |   |
| None  |   |   |
| <b>RESULTS</b>  |   |   |
| None  |   |   |
| <b>IMPLICATIONS FOR RESEARCH, PRACTICE AND/OR SOCIETY</b>                                     |   |   |
| None  |   |   |
| <b>QUALITY OF COMMUNICATION</b>   |   |   |
| p6 l2 (Table 1 caption) should be "attempts" not "attempt"                                    | Pg. 6, line 2                                 | "attempt" has been replaced by "attempts"   |
| p6 l4 "what is" is redundant  | Pg. 6, line 4                                 | "what is" has been deleted<br>"... to understand what is the impact..."                           |
| p6 l6 missing word - dive deeper "into" this scope?   | Pg. 6, line 6                                 | "into" has been added<br>"To dive deeper into this scope..."                                      |
| p7 l39 "what is" is redundant   | Pg. 7, line 39                                | "what is" has been deleted<br>"...to understand what is the impact..."                            |
| p11 l28 missing "from" ("disconnected one another")   | Pg. 11, line 24                               | "from" has been added<br>"disconnected from one another"  |
| p11 l45 in the revised numbering c) has been repeated, should be e)                           | Pg. 11, line 40                               | in the numbering c) has been replaced by e)   |
| p12 l11/12 grammar needs correcting in this expression  | Pg. 12, lines 11-12                           | The sentence has been amended.  |
| p13 l5/6 grammar correction - second "to" is redundant (to whom employees start referring to) | Pg. 12, line 47                               | the second "to" has been deleted<br>"These professionals - to whom employees start referring to - |
| p13 l12 replace "unsatisfied of" with "dissatisfied by"                                       | Pg. 13, line 5                                | "unsatisfied of" has been replaced by "dissatisfied by"   |
| p13 l22 "one to another" is redundant   | Pg. 13, line 15                               | "one to each other" has been deleted<br>"...are transparent and aligned one to each other"        |
| p13 l37-40 this sentence "Starting with..." is incoherent                                     |   | This sentence has been deleted.   |
| p14 l6 replace "but currently not connected" with "but who are currently not connected"       | Pg. 13, line 38                               | "but currently not connected" has been replaced with "but who are currently not connected"        |
| p14 l6 "one to each other" is redundant   | Pg. 13, line 38                               | "one to each other" has been deleted  |
| p14 l21 "makes also" should be "also makes"   | Pg. 14, line 9                                | "makes also" has been replaced with "also makes"  |
| p14 l34 "has also" should be "also has"   | Pg. 14, line 21                               | "has also" has been replaced with "also has"  |
| p14 l39 "in-depth further analyses" should be "further in-depth analyses"                     | Pg. 14, line 26                               | "in-depth further analyses" has been replaced with "further in-depth analyses"                    |
| p15 l21 replace "potentialities" with "potential"   | Pg. 15, line 15                               | "potentialities" has been replaced with "potential"   |
| p15 l26 "thereby" is redundant  | Pg. 15, line 20                               | "thereby" has been deleted  |

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|                                |                 | "... must <del>thereby</del> undergo..."  |
| p15 l26 "the way" is redundant | Pg. 15, line 20 | "the way of" has been deleted<br>"... a deep business transformation<br>by the way of re-configuring their<br>organizational structures." |



| REVIEWER (2) COMMENT  | Pg. & line no. where the comment is addressed  | DESCRIPTION OF HOW I ADDRESSED THE COMMENT  |
|---|--|---|
| <b>ORIGINALITY</b>  |  |   |
| <p>“Please highlight the novelty of the study and how it is unique, on the conclusion. It is missing from the manuscript.”</p>  | Pg. 14, lines 31-43  | <p>The novelty of the study has been highlighted in the conclusions section too by underlining how most of the research about the impact of digital technologies on organizations so far has studied the new forms of <i>project organization</i> adopting network theory as a lens for their design and management. However, less attention has been rather paid to the power of network theory for understanding and managing the new forms of <i>firms’ organization</i> associated with digital transformation. Also, even if the literature about organization design and management acknowledges the importance of both <i>formal and informal structures</i> for understanding organizations and their performance, so far, most research has focused on these two structures independently and has not fully understood their <i>interplay</i>.</p> |
| <b>RELATIONSHIP TO LITERATURE</b>   |  |   |
| None  |  |   |
| <b>METHODOLOGY</b>  |  |   |
| <p>“Another limitation is that your results might be specific to the type of digital technology on your case project. Other types of digital technology can show findings and trends different to yours. Please mention such factors among the limitations of your study, to inform future areas for research.”</p> | Pg. 15, lines 42-43<br>Pg. 16 lines 5-6  | <p>This other limitation of the study has been mentioned in the ‘Limitations and future directions’ section (lines 42-43) also by linking it to future areas for research (lines 5-6).</p>  |
| <b>RESULTS</b>  |  |   |
| <b>IMPLICATIONS FOR RESEARCH, PRACTICE AND/OR SOCIETY</b>   |  |   |
| <b>QUALITY OF COMMUNICATION</b>   |  |   |
| <p>“Some sentences are very long and difficult to follow. Similarly, headings are too long. Please amend and use meaningful, yet concise headings throughout the manuscript.”</p>   | Pg. 1, lines 37-40<br>Pg. 2, lines 26-29, 41-45<br>Pg. 3, lines 1, 38<br>Pg. 4, lines 40-42<br>Pg. 5, line 1, lines 3-6<br>Pg. 8, lines 14, 33<br>Pg. 9, lines 25-28<br>Pg. 10, line 6, 33<br>Pg. 11, line 11<br>Pg. 12, lines 17, 27-29, 38 | <p>Very long and difficult-to follow sentences have been shortened, mostly by splitting the sentence into two. Too long headings have been amended. Amended sentences and headings have been highlighted in green throughout the text.</p>  |

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|   | Pg. 13, lines 21, 32-37<br>Pg. 14, lines 14-17<br>Pg. 15, lines 28-32<br>Pg. 16, lines 10-12 |  |
| “Some key definitions are presented on the 3rd or 4th page of the manuscript. Any potential reader needs definitions early on the manuscript to appreciate the terms and concepts.” | Pg. 1, lines 46-47<br>Pg. 2, lines 1-4<br>Pg. 2, lines 22-25                                 | Key definitions of formal structure, informal structure and digital transformation have been presented in the first and second page of the manuscript. |