

The chief digital officer: building dynamic capabilities for digital transformation

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Abstract

Digital transformation is increasingly high on the strategic agenda of organizations, with many appointing chief digital officers – senior executives with cross-functional digital transformation responsibility – to lead the digital transformation agenda. However, digital transformation is not a single event run as a finite program and organizations require ongoing strategic renewal as technology and business model opportunities are created. Therefore, a chief digital officer must not only deliver on near-term digital transformation priorities, but also enable the organization for ongoing digital transformation in the future. This article describes the findings from 10 semi-structured interviews with chief digital officers, heads of digital, and digital capability leads, exploring the capabilities they are creating to enable their respective organizations' ongoing digital transformation. It was found that chief digital officers are building the sensing, seizing, and transforming dynamic capabilities of their organizations and this article describes five capabilities that chief digital officers are building to enable ongoing digital transformation in their organizations: (1) scanning, (2) experimentation, (3) digital strategy making, (4) agile delivery, and (5) organizational change.

Keywords

Digital transformation; Dynamic capabilities; Chief digital officer; Strategy

Declaration

I declare that this article is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Heinrich Pool

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1 Cover letter

Mr Gregory C. Fisher
Editor – Business Horizons
Indiana University Bloomington Kelley School of Business
Bloomington, Indiana
United States

Dear Mr Fisher,

I am writing to submit for your review our manuscript titled, “The chief digital officer: building dynamic capabilities for digital transformation”. The creation of a new c-suite role, that of the chief digital officer, reflects the growing strategic importance of digital transformation. This is aligned to your own call to us in your presentation to our MBA cohort for research into digital transformation. While relatively under-researched, the extant research into the role of the CDO is still largely qualitative and exploratory and has not been discussed in Business Horizons since Gerth & Peppard reviewed the dynamics of CIO derailment in 2016.

Through interviews with ten CDOs and digital transformation leaders, we have learnt that CDOs are building the dynamic capabilities of their organisations, by building sensing, seizing, and transforming capabilities that enable the ongoing digital transformation of their organisations. This work brings together elements from the work of Teece (2016), in entrepreneurial management, the work of Warner & Wäger (2019) in dynamic capabilities and the process of ongoing strategy renewal in digital transformation. For business academia this article addresses a gap in how digital transformation leadership can take an intentional role in building the dynamic capabilities of the organisation, and sheds new light for practitioners on how new CDOs can build dynamic capabilities in their organisation which will better position their organisation to achieve ongoing digital transformation.

Both authors confirm that by submitting this manuscript, that they agree to engage in the review process and for the article to be published should it be accepted. Both authors confirm that this manuscript has not been submitted for consideration with any other journal. Each of the named authors has contributed significantly to the research and, to the best of our knowledge, have no conflict of interest to declare.

Sincerely,

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Motivation for selecting Business Horizons

The Business Horizons journal has an Academic Journal Guide rating of 2 as per the 2019 publication by ABS and is Scopus indexed. Business Horizons aims to straddle the worlds of business academia and business practitioners and seeks manuscripts written in non-technical language that make judicious use of source citations that deliver prescriptive approaches to solve problems. There are several recent publications in the field of digital transformation in the journal, but the nascent role of the chief digital officer has not been discussed since a 2016 article on CIO derailment by Gerth & Peppard. There is call for research into digital transformation from the journal and the journal accepts qualitative research. Business Horizons expects journal manuscripts of no longer than 25 pages, using APA referencing, and following strict guidelines for format of page and text, to which the manuscript complies.

2 Literature Review

2.1 Introduction

Digital transformation is of strategic importance to pre-digital organisations (Hess et al., 2016). Not only are technological shifts enabling new competing products and services to be delivered to market (Horváth & Szabó, 2019; Sebastian et al., 2017), but digitally native organisations are encroaching on the markets of incumbents (Chanias et al., 2019), and doing so at lower cost and providing improved customer experiences, disrupting existing business models (Downes & Nunes, 2013). Organisations have responded to this challenge by adopting approaches to digital business strategy (Bharadwaj et al., 2013), in order that they may create and execute a digital transformation strategy (Matt et al., 2015). Digital transformation is a complex, cross-functional issue and many organisations have elevated it in the strategic agenda by appointing a Chief Digital Officer (CDO) (Singh & Hess, 2017; Tumbas et al., 2017).

The role of the CDO has existed for less than two decades (Kunisch et al., 2020; Singh & Hess, 2017), and as the digital transformation priority grows amongst organisations analyst reports indicate rapid growth in the number of CDO roles (Egon Zehnder International, 2019). Research into the nature of the role of the CDO has largely been exploratory and qualitative in nature, seeking to understand the reasons organisations adopt the role (Tumbas et al., 2017), how CDOs promote digital transformation (Singh & Hess, 2017), how organisational parameters influence the CDO role (Horlacher et al., 2016; Singh et al., 2020), and what makes a CDO successful (Berman et al., 2020). As the orchestrator of the digital transformation of the organisation, the CDO must contend with the continuous change and disruptive to the nature of the competitive environment due to digital transformation (Downes & Nunes, 2013; Vial, 2019).

The dynamic capabilities framework views dynamic capabilities as an organisation's ability to rapidly adjust internal and external competences in response to rapidly changing competitive environments (Teece et al., 1997), which has been proposed as an interesting conceptual fit with the continual and rapid disruption in digital transformation (Vial, 2019). Recent research has shown that dynamic capabilities may play a role in responding to digital disruption (Karimi & Walter, 2015), aligning to digital strategy (Yeow et al., 2018). Warner and Wäger (Warner & Wäger, 2019) have conceptualised digital transformation as an ongoing process of strategic renewal and proposed a process model for building dynamic capabilities for digital transformation. While the research into dynamic managerial capabilities shows a measurable impact from the role of managers in responding to changes in the external environment, the

construct views the managerial human capital, managerial social capital and managerial cognition at a collective level within the organisation (Adner & Helfat, 2003). Teece's (2016) conception of the entrepreneurial manager and describes their role in sensing opportunities, seizing opportunities and transforming the organisation, which shows a great similarity to the perspectives of CDOs in their role of digital innovators and institutional entrepreneurs (Tumbas et al., 2018).

It is in this role of digital innovator, institutional entrepreneur, and entrepreneurial manager, that defined the purpose of this study, to explore the role of the CDO in building the dynamic capabilities of the organisation for digital transformation.

2.2 The role of the chief digital officer

The role of CDO has no broadly accepted definition but shares key attributes across the definitions that do exist in recent research. Singh and Hess (2017) define the CDO role as the executive responsible to orchestrate the digital transformation of the organisation. Tumbas, Berente and von Brocke (2017) define the role of the CDO as helping their organisations to use digital technologies to create business value, by developing digital capabilities in relevant domains with a continuous focus on seizing new opportunities that arise from questioning the business model, using customer-centeredness and using a variety of data to gain insights. Berman, Baird, Eagan and Marshall (2020) define the CDO as the business executive responsible for creating and executing strategies for digital solutions across their enterprise. Since the first CDO was hired by MTV in 2005, the CDO is now one of the fastest-growing C-level positions and is a global phenomenon (Singh & Hess, 2017).

While a few view the role of the CDO and chief information officer (CIO) to be nearly interchangeable (Gerth & Peppard, 2016), most CDOs, unlike their CIO counterparts have no information technology (IT) operational responsibility and, in many cases, have no profit and loss accountability. CDOs have a wider role than heads of individual business units and functions, and assume cross-functional authority for digital transformation initiatives (Singh & Hess, 2017). Further, Tumbas, Berente and vom Brocke (2018) explored the role of the CDO through the perspective of thirty-five organisations and in their findings they highlight that CDOs made a distinction between the "digital" domain in which they operate and the existing IT domain, in contrast to the interchangeability proposed by Gerth & Peppard (Gerth & Peppard, 2016). CDOs highlighted the strategic relevance of their activity with a strong articulation of the value creation through new revenue streams. The CDOs described their process of goal achievement of their innovations as being driven through experimentation.

CDOs largely model their organisational behaviour on that of digital start-up and technology giants (Tumbas et al., 2018). They take many of the principles of their way of operation from these examples in that they favour fast execution and delivering value to customers incrementally so that they are able to avoid bureaucracy, and they place digital transformation at the heart of the organisational strategy. Some CDOs considered their primary focus to be on customer-facing processes and set their objectives on end customers of digital products and services (Tumbas et al., 2018). While some organisations were able to navigate their digital transformation objectives under the leadership of their traditional IT functions and the leadership of the CIO, many organisations were not able to do so (Singh & Hess, 2017; Tumbas et al., 2017). The focus of the traditional IT organisation was largely on technological infrastructure and systems such as enterprise resource planning and customer relationship management and while IT had to consider all business functions that they supported, the CDO could focus near-exclusively on the customer value creation opportunity (Tumbas et al., 2018).

The location and reporting lines of the CDO in the organisation has an impact on how the CDO pursues the digital transformation. Singh, Klarner and Hess (2019) examined the manner in which CDOs pursue digital transformation activities with specific focus on the organisation design parameters and found that the role of the CDO is influenced in terms of the method by which they anchor the digital transformation strategy and their primary task focus dependent on whether the CDO is centrally or de-centrally appointed in the enterprise (Singh et al., 2020). Further research found that this central or decentral appointment would have an influence on the nature of the horizontal coordination mechanisms that would be employed by the CDO, making use of formal mechanisms and informal mechanisms (Horlacher et al., 2016; Singh et al., 2020).

In order to formulate the digital transformation strategy and execute thereon, CDOs need to sense the environment for emerging digital technologies and then work to build digital capabilities in their organisations (Matt et al., 2015; Singh & Hess, 2017). Several CDO domains surface from the research and include the digital innovation domain (Tumbas et al., 2017), focused on building digital capabilities for experimentation and transforming organisational processes, products, services and business models; the data analytics domain which is focused on building capabilities for gaining insights into internal and external data; and the customer engagement domain which is focused on establishing outstanding customer-focused experiences to the customers of the organisation through digital capabilities. (Tumbas et al., 2017)

The CDO needs several key competencies. The first is IT competency which a CDO will leverage to define and communicate IT requirements for new digital products and services (Singh & Hess, 2017; Tumbas et al., 2017). The CDOs role is highly cross-functional and interdisciplinary and the CDO requires deep business acumen, not only in an understanding of the business model, processes, and customers of the organisation, but also the inner workings of the various functions of the business. In order to successfully execute the digital transformation of the organisation, the CDO must possess inspiration skills with which to inspire others in the organisation. The CDO must be able to recognise the needs of others and help them to overcome barriers that arise during the transformation. The CDO must possess what Singh and Hess (2017) describe as digital pioneering skills in that the CDO must be a high level, visionary thinker, able to create a cohesive digital strategy for the organisation, and be able to look at the current and prospective business situations from many different perspectives. Due to the transformational nature of the role, the CDO requires resilience, even more so in traditional organisations where the change required will be more substantial (Singh & Hess, 2017).

Even at this early stage of the life of the role of CDO, patterns of behaviour are being understood and defined from the research. Singh and Hess (2017) identify three role types of CDOs, the entrepreneur role, the digital evangelist role, and the coordinator role. While the role in any one organisation may demand that the CDO plays all three of these roles to varying degrees, a number of internal organisational factors such as the digital transformation maturity of the organisation, the digital mindset of the workforce, the company size and the reporting relationships of the CDO, have an influence on the primary role that is played by the CDO (Hess et al., 2016; Singh et al., 2020; Singh & Hess, 2017)

In a similar fashion, with a view to the primary objectives of the CDO, rather than the core competencies of the CDO, Tumbas, Berente and von Brocke (2017) identify three types of CDOs, the digital accelerator CDO who focuses on digital innovation through experimentation, implementation and implementing a bimodal approach to IT, allowing the IT department to focus on the underlying infrastructure; the digital marketer CDO who focuses on data analytics with the objective of customer intimacy and the intention to create a consistent customer experience across digital and non-digital channels; and the digital harmonizer CDO with a focus on customer engagement by integrating digital capabilities across the enterprise, breaking down and integrating across the silos that exist in the organisation. (Tumbas et al., 2017)

Companies are best suited to create the position of CDO when there are high levels of external market pressure to transform digitally and where there is great internal complexity in co-ordinating transformation activities across the company (Kunisch et al., 2020; Singh & Hess, 2017; Tumbas et al., 2017). Singh and Hess (2017) identify four key lessons learned around the role of the CDO. The first is that top management should ensure that the CDO has sufficient authority to execute the transformation across business units and functions, often a factor of organisational parameters (Berman et al., 2020; Horlacher et al., 2016; Singh et al., 2020). The second is that CDOs should develop and hone the skills required for the particular type of CDO role that is required in the organisation. The third is that while some CIOs see the appointment of a CDO as a threat, the focus on digital transformation may support the CIO in gaining a more influential seat at the leadership table (Sebastian et al., 2017; Singh & Hess, 2017; Tumbas et al., 2018). The fourth is that the role of the CDO may be temporary and be in place only whilst the company is in the process of transforming digitally (Egon Zehnder International, 2019; Péladeau & Acker, 2019; Singh & Hess, 2017).

2.3 Dynamic capabilities for digital transformation

The dynamic capabilities framework is means by which the creation of sustainable competitive advantage by organisations competing in environments of rapid technological change can be analysed (Teece et al., 1997). The dynamic capabilities framework defines competitive advantage to be the management processes of the organisation, its asset position, and the paths available to the organisation considering path dependencies that may exist. The defined dynamic capabilities is defined as "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece et al., 1997, p. 516). Eisenhardt and Martin (2000) compared and contrasted the resource based view of the organisation and dynamic capabilities. They argued that dynamic capabilities are not necessarily idiosyncratic to the organisation, but that there are well-known dynamic capabilities, such as new product development, mergers and acquisition and strategic decision making. However, they further conclude that more dynamic markets demand more rapid rates of change in resource configuration and that there exists a rate limitation at which the resource based view accommodates this rate of change (Eisenhardt & Martin, 2000), which indicates that dynamic capabilities may well apply at the rapid rate of change of digital transformation (Downes & Nunes, 2013; Warner & Wäger, 2019).

Digital transformation has become a strategic imperative for incumbent traditional organisations and the pace of change in traditional industries is accelerating (Bharadwaj et al., 2013; Karimi & Walter, 2015; Vial, 2019). Karimi & Walter (2015) found the dynamic

capabilities framework to be a useful lens through which to study digital transformation. They evaluated the development of sensing capabilities and determined that organisations need to build generative sensing capabilities that test multiple hypotheses and allow managers to make sense of surprising events and unexpected trends, seizing capabilities through the implementation of agile methods and technologies that will allow for rapid experimentation and implementation of new business models, and transforming capabilities to institutionalise an on-going strategic renewal by improving the digital maturity of the workforce (Karimi & Walter, 2015). Digital transformation requires not only that products, services and processes are transformed, but that the workforce transform to a digital mindset and a digital way of working (Davison & Ou, 2017; Dittes et al., 2019).

A study on the impact of digitalization on the business models of organisations in the automotive and media industry and found that it was necessary for such organisations to be able to adjust their business models through sensing capabilities that provide them with the ability to identify new opportunities and threats, seizing capabilities that will allow them to be able to offer products and services to meet changing market opportunities, and transforming capabilities that allow the company to reconfigure itself to the new business model. (Rachinger et al., 2019) In digital transformation of the organisation, it is important to ensure tangible value creation for the organisation through the development of innovation digital products and services (Nylén & Holmström, 2015). However, it is not enough to gain user adoption or digitalisation of processes, but to achieve value creation for the customer and value capture for the company. Teece and Linden (2017) note that many companies, in the development of new digital products, seek to follow in the footsteps of a small number of firms that have achieved success by giving their product away for free before knowing how to monetize their user base. This is not only happening in digital product companies, but in physical product companies who are launching new digital products and services (Chaniias et al., 2019; Karimi & Walter, 2015), and as such it is important for value creation for customers through new digital products and services to be accompanied by value capture for the firm (Schoemaker et al., 2018; Teece & Linden, 2017).

In order to create and capture this value, the organisation must adjust its business model. Teece (2018) describes a business model as the design or architecture of how an organisation creates value for customers, delivers that value and captures value for the organisation. He describes a business model being consistent of nine components grouped into three categories: value proposition, which includes the components product & service, customer needs and geography; revenue model, which includes the components pricing logic, channels, and customer interaction; and the category cost model, which includes the components core

assets & capabilities, core activities, and partner network. Teece then further describes management's ability to develop and refine business models as a core micro foundation of dynamic capabilities (Teece, 2018) and explores more fully the role of the entrepreneurial manager in identifying and acting upon these business model opportunities (Teece, 2016; Tumbas et al., 2018).

The US military coined acronym VUCA (volatility, uncertainty, complexity, and ambiguity) which is now used widely in the business world to describe the nature of the challenges faced by business leaders (Schoemaker et al., 2018). Dynamic capabilities are important in dealing with turbulent environments and markets, allowing organisations to responding to external and internal changes. The clusters of dynamic capabilities of sensing market changes before rivals do, seizing capabilities by successfully innovating and implementing changes that capitalise on the changes occurring in the market, and transforming capabilities which are required for the organisation to be able to reshape itself to the changing market conditions and opportunities that have been sensed and seized, quite possibly changing the nature of the business. (Schoemaker et al., 2018)

Warner and Wager (2019) found that the convergence and generativity of digital technologies makes building dynamic capabilities a strategic imperative for incumbent organisations to survive in the digital age. They highlighted that a number of dynamic capabilities are required across the realms of sensing, seizing, and transforming the organisation and that digital transformation involves an on-going strategic renewal of the organisation. Such an on-going strategic renewal will demand changes in the way in which business units and functions within the organisation work together. These changes will likely bring about a change in the culture of the organisation. They further indicated that the process of digital transformation was not static, and that external market conditions are likely to change, triggering a need for sensing, and seizing of new opportunities. (Warner & Wäger, 2019)

Yeow, Soh and Hansen (2018) researched the alignment with new digital strategy through the dynamic capabilities lens and found that the alignment to digital strategy process is enacted through sensing, seizing and transforming dynamic capabilities. They further found that through the process of strategic renewal that organisations should remain attentive to the emergent tension that arises to successfully navigate the digital strategy transformation. (Yeow et al., 2018)

Teece (Teece, 2016) describes that economic theory has long described the behaviour of the organisation and the market but has neglected to more deeply concern itself with the

behaviour of the manager within the business and describes the senior managers as the core actor in the organisation. He describes three roles for managers in the organisation: the operational role which is responsible for the execution of current plans through planning, budgeting, organising and staffing, applying control and problem solving, with the aim of achieving efficiency and predictability; the entrepreneurial role which is responsible for sensing market opportunities by investing in research and development, and seizing those opportunities by orchestrating resources and developing new business models, with the objective of achieving and maintaining competitive advantage; and the leadership role which is responsible for propagating the vision and values of the organisation, aligning people with the strategy and motivating them to achieve the necessary transformation with a unity of purpose. (Teece, 2016)

As we have seen, extant research into the role of the CDO has delivered exploratory insight into the types of CDO role that exist (Singh & Hess, 2017; Tumbas et al., 2017). These CDO types and CDO role types define different competences and objectives for the role. There are common themes within these CDO role type which show alignment to the entrepreneurial manager (Teece, 2016; Tumbas et al., 2018). These various CDO role types bear further resemblance to the clusters of dynamic capabilities, sensing, seizing and transforming (Warner & Wäger, 2019). This study further explores the role of the CDO in building these types of dynamic capabilities.

2.3.1 Sensing capabilities

With an outward focus on changing external conditions, sensing capabilities enable the organization to identify novel value capture opportunities. Teece's (2016) entrepreneurial manager shows the entrepreneurial describes a manager that identifies new opportunities to act upon to create competitive advantage. The digital accelerator CDO type of Tumbas, et al. (2017) describes a CDO that focuses on digital innovation with an objective of experimenting with and implementing new digital business models, which shows strong alignment to the entrepreneur CDO type described by Singh & Hess (Singh & Hess, 2017).

This study therefore asked, what is the role of the CDO in building the sensing capabilities of the organization?

2.3.2 Seizing capabilities

Enabling the organization to seize the opportunities for value capture, and adjust the business model of the organization can be done within the organization or as a standalone organization, and the entrepreneurial manager is seen as the leader for this (Teece, 2016). Elements of this activity can be seen in the digital marketer CDO type (Tumbas et al., 2017) who exhibits key capabilities in data analytics and customer intimacy, creating consistent experiences for customer across all channels, as well as elements of the entrepreneur CDO role type whose primary objective is not only to experiment, but also to implement digital innovation (Singh & Hess, 2017).

To explore this further, this study asked, what is the role of the CDO in building the seizing capabilities of the organization?

2.3.3 Transforming capabilities

Digital transformation does not end with the implementation of novel value capture opportunities, but requires organization-wide commitment and transformation (Bharadwaj et al., 2013; Saarikko, Westergren & Blomquist, 2020; Yeow et al., 2018). This requires considerable transformational leadership to propagate the vision and values of the organization and motivate people behind a unifying purpose (Teece, 2016). The organization-wide transformation requires that the leader communicate widely across functional areas of the organization and to inspire the organization to work across organizational silos, relying on attributes of both the digital evangelist and coordinator CDO role types (Singh & Hess, 2017) as well as the digital harmonizer CDO type, whose primary objective is the enterprise integration of the digital transformation (Tumbas et al., 2017).

Finally, this study asked, what is the role of the CDO in building the transforming capabilities of the organization?

2.4 Conclusion

We have seen through the development of the literature review, that digital transformation is growing in relevance, importance, and urgency on the strategic agenda of the organization (Bharadwaj et al., 2013; Downes & Nunes, 2013; Hess et al., 2016; Matt et al., 2015). Organizations are appointing CDOs to lead and orchestrate their digital transformation (Berman et al., 2020; Singh & Hess, 2017; Tumbas et al., 2017). This involves the development of digital transformation strategies (Hess et al., 2016; Matt et al., 2015; Sebastian et al., 2017), working across functions within the organization and influencing an organization-

wide transformation. The starting point of the organization as well as the industry conditions in which it finds itself determines the nature of the CDO role that is required to be fulfilled, and the manner in which the digital transformation strategy will unfold (Chanias et al., 2019; El Sawy et al., 2016; Horváth & Szabó, 2019; Sebastian et al., 2017). Digital transformation is not expected to be a once-off activity, and it is expected that technology and market conditions will continue to change in disruptive ways (Downes & Nunes, 2013; Warner & Wäger, 2019). By building dynamic capabilities to enable digital transformation, organizations may achieve the ability to manage the ongoing strategic renewal will be required (Warner & Wäger, 2019), to continually adjust their business models to capture new value (Teece, 2018). The role of the leader of digital transformation, the CDO, is therefore crucial in providing the entrepreneurial management that is required to drive this change and foster its adoption in the organization (Teece, 2016; Tumbas et al., 2018).

Three research questions were developed throughout this literature review, to explore the role of the chief digital officer in building dynamic capabilities for digital transformation:

What is the role of the CDO in building the sensing capabilities of the organization?

What is the role of the CDO in building the seizing capabilities of the organization?

What is the role of the CDO in building the transforming capabilities of the organization?

3 Research Methodology

3.1 Introduction

The aim of this research was to explore the role of the CDO in creating and maintaining the dynamic capabilities of the organisation. The research method selected was therefore qualitative and exploratory in nature and set out to generate theoretical insights, rather than to test theory (Tumbas et al., 2018). Due to the nascent nature of the role of the CDO, the small body of extant research was largely qualitative and exploratory in nature (Horlacher et al., 2016; Singh et al., 2020; Singh & Hess, 2017; Tumbas et al., 2017, 2018). This research approach was chosen to build upon the existing research, while further exploring the novel perspective of the CDO's role in creating and maintaining the dynamic capabilities of the organisation.

The rich research data was collected via means of semi-structured in-depth interviews with CDOs, which explored their own perspective on their role (McCracken, 2011; Rowley, 2012). The inductive approach to theory development allowed for a reflexive approach in the interview execution, whereby later interviews could be adjusted through adjustment of the interview questions and supporting probing questions after reflection and analysis (Qu & Dumay, 2011). This research method and the nature of the individual perspective and context was in accordance with the selection of the interpretive paradigm (Mathison, 2005), selected in previous research into digital transformation (Chanas et al., 2019) and the narrative approach as the means by which to gain the perspectives of the informants and their lived experience (Clandinin, 2006; Tumbas et al., 2018). This lived experience was likely to be newly started and still developing, as analyst reports indicated that most CDO positions were newly created and that most CDOs were new to the position (Egon Zehnder International, 2019; Péladeau & Acker, 2019).

3.2 Unit of analysis and population

The unit of analysis of the research was the individual CDO, as the research sought to explore the CDO's perspective on whether they played a role in creating and maintaining the dynamic capabilities of the organisation, and if so, to explore the nature of the role they played in doing so. From the broad definition of the CDO role, that of a senior executive, responsible for the orchestration of the digital transformation of the organisation (Singh & Hess, 2017), the population was defined as senior executives responsible for the digital transformation of their organisation, to allow for role naming variation across organisations in the South African

context of the study. This broader role title scope included CDOs, Vice Presidents, Heads of Digital and other variations that all had “digital” as a common element, similar to the approach used in recent research into the CDO role (Kunisch et al., 2020), while maintaining conceptual alignment to the CDO role itself. While the population was not expressly linked to the South African context, the sampling method applied originated predominantly South African interviewees.

3.3 Sample

Potential candidates were identified via purposive, non-probabilistic sampling. The primary channel of search was LinkedIn, where search terms matching the identified role titles from the population were applied and candidates identified. These candidates were then contacted via LinkedIn connection request, with a short-form introduction and request to engage regarding participation in the research, as well as by LinkedIn InMail, which allowed a longer-form introduction and request to engage (Tumbas et al., 2017). The short- and long-form introduction and request followed the eight recommendations of Rowley (2012) to select and enlist potential interviewees. Further recommendations and introductions were sought through academic and professional networks, utilising the same recommendations and communication practices. At each interview a request was made to the interviewee for recommendations to potential candidates, but this approach did not yield any additional candidates.

The application of these sampling methods resulted in direct communications with 29 interview candidates and yielded ten semi-structured in-depth interviews of one hour in scheduled duration. The interview candidates included in the final sample of ten interviews covered a variety of industries with five from financial services, two from telecommunications and one each from consumer goods, automotive & logistics, and the pharmaceutical industry. Each of the organisations and their industries were identified as incumbent, non-digital organisations in need of digital transformation (Chanas et al., 2019; Singh & Hess, 2017). Among the interview candidates, three had the title of CDO, four had various incarnations of Head of Digital, and three bore specific digital capability leadership titles, such as Head of Digital Research & Development.

3.4 Measurement instrument

The measurement instrument for the semi-structured in-depth interviews was an interview guide. The objective of the interviews, following the interpretivist narrative approach, was to explore the real world lived experience of the interviewee, from their perspective. To this end the interview guide was relatively unstructured with six main questions, each supported by between three and six supporting prompts (Kallio et al., 2016; Rowley, 2012). A limitation of this approach to the semi-structured interview could be that the interviewee drifts off topic and provides information which is not useful to the study, for which purposes the supporting prompts were design to bring the interview in line with the questioning, without being leading (Roulston, 2010). The final interview guide is appended to this document which will ensure that future researchers could apply similar questions in their research if this topic should be researched further (Qu & Dumay, 2011; Roulston, 2010).

Before starting the formal questions, the interview guide included prompts around introductions, ensuring that the informed consent forms were signed, verifying that the interview can be recorded and initiating the recording. A brief discussion about the interviewee and the researcher's "work from home because of COVID-19" status was all but guaranteed and functioned as a good ice-breaking conversation.

The first question explored the background of the interviewee, their education and professional history, and enabled discovery of whether the role existed at the organisation before their appointment, who created the role and why it was created. This question and its prompts were designed to allow the interviewee to settle into the interview with a familiar topic, culminating in an appointment they were likely proud of. Simultaneously the question helped to address some understanding as to why the role was formed by the organisation and what the reporting lines of the interviewee are (Horlacher et al., 2016; Singh et al., 2020).

The second question addressed the general expectations of the interviewee in their role. This question was created to explore such aspects as the interviewee's role in organisational strategy setting, and how they are measured for success in their role. This question further allowed the interview to describe the organisation they led, if they led one, and what their financial responsibilities were within the organisation, and their relationship to their peers and other executives such as the CIO (Gerth & Peppard, 2016; Singh et al., 2020), and also their interactions with the board. The probing question was not in the original interview guide in the first interviews but was added as a reflexive learning later in the process when an interviewee offered that they were surprised that the question had not been asked.

The third, fourth and fifth questions were specifically explorative of the role of the CDO in creating and maintaining the dynamic capabilities of the organisation. Question three explored the role of the interviewee in sensing change and opportunities for their organisation (Schoemaker et al., 2018; Teece, 2016). The probing questions in support of question three allowed the opportunity for the interviewee to expand on such topics as scanning for trends (Warner & Wäger, 2019), identifying opportunities (Singh & Hess, 2017), engaging with customers (Tumbas et al., 2017), the role of data in sensing opportunities (Tumbas et al., 2017), the organisational changes and organisational routines introduced, and the approach to experimentation with new opportunities introduced by the interviewee (Tumbas et al., 2018).

The fourth question was designed to explore the role of the interviewee in seizing opportunities, the second pillar of dynamic capabilities framework (Schoemaker et al., 2018). This question, and the probing questions, allow for the interview to elaborate on their experience in capturing new business models (Rachinger et al., 2019; Teece & Linden, 2017), new technologies and new processes in the organisation, who leads those initiatives, how they are executed in the organisation, the methodologies and work practices that are applied in execution (Guinan et al., 2019), and the organisational changes and routines that are changed or introduced by the interviewee (Teece, 2016; Tumbas et al., 2018).

Question five addressed the third pillar of the dynamic capabilities framework and explored the role of the interviewee in the transformation of the organisation (Teece, 2016). Probing questions explored the vision of the organisation, the culture of the organisation, the adaptability of the organisation, the organisational changes and routines introduced and changed by the interviewee to enable the business to transform throughout to newly seized business models (Hinings et al., 2018). This question also sought to address the leadership attributes of the interviewee (Teece, 2016). The sixth and final question arose as a reflexive response to a prompt from an interviewee about the fact that board interactions had not been addressed in the interview. This question was therefore an open exploratory question to identify whether there was anything that had come to mind for the interviewee that they would like to share, which had not been explicitly prompted.

3.5 Data collection

Data was collected in the form of in-depth semi-structured interviews with the ten interviewees that confirmed through the sampling and search process. Informed consent letters were shared with the candidates in advance of the interviews and confirmed the confidentiality of the interview data, of both an individual and organisational nature, to address informant bias,

as well as confirming that the interviews would be recorded for transcription purposes. The informed consent letters further stipulated that the participation of the candidate was fully of their own will and that they were in no way being coerced to participate. The intention of the study was explained, without revealing much about the dynamic capabilities framework, so as to avoid creating demand characteristics altering the responses (Qu & Dumay, 2011).

Interviews were initially expected to last 90 minutes and to be run via video conferencing mechanisms. Due to the digital, remote medium forced by COVID-19 restrictions, it was originally planned that the interview could be divided into two parts of 45 minutes to accommodate the diaries of these senior executives. The medium persisted, but a pilot interview demonstrated that due to the encouragement to the interviewee to reflect and talk, and the flexible conversation flow of a semi-structured in-depth interview (Rowley, 2012), that it would work best to shorten the interview time to one hour to achieve availability and complete the interview in a single sitting. The shortened interview time led to an increase in the planned sample size. The proposed approach was to perform in-depth semi-structured interviews with six CDOs, and this number was increased to ten based on the shorter interview time of one hour (Rowley, 2012).

The interviews were held over a period of 54 days via video conference software. In most cases candidates were more comfortable turning their video feed off after the initial introductions and turned the video feed on again at the end for thanks and greetings. The interviews generated 09:05 (nine hours and five minutes) of audio recordings, at an average of 54 minutes per interview. The shortest interview was 42 minutes long and the longest 01:10 (an hour and ten minutes). The audio recordings were transcribed in two phases.

The first phase of transcription utilised the Microsoft Word Online transcription feature, which applied natural language processing to the audio file to generate a transcript. In the second phase the audio was matched to the transcription result by the researcher and updates made as necessary. The manual updates included correcting language use, incorrect transcriptions, as well as anonymising the transcripts – replacing names of people and organisations with anonymous identifiers. The transcribed interviews generated 89,107 words and 293 pages of text, including speaker identifiers and timestamps. The shortest interview transcript comprised 6,629 words on 23 pages, the longest 12,230 words on 43 pages and the average for all interview transcripts was 8,911 words on 29 pages. Manual interview notes and field notes from the interviews were kept in a handwritten journal and were used as a reference in cases where the audio recording was unclear, or a transcription uncertainty occurred.

3.6 Data analysis

Interview transcripts were analysed in the qualitative data analysis software ATLAS.ti. The transcripts were loaded into the software and chronologically processed for coding. The transcripts were read word for word and coded from the meaning in the interview response text (Hsieh & Shannon, 2005). The initial codes came directly from the text, but where they may have been used in later coding their name was not updated. As additional codes were developed in subsequent transcriptions, previous transcripts were reviewed for that coding, as well as for whether codes with similar meanings had been created. Initially 189 codes were created, but after reviewing all the coding across all transcripts a total of 126 codes were retained. While the theoretical framework of dynamic capabilities was the core theoretical construct, the capability clusters of sensing, seizing and transforming were too large to define the coding of the analysis. The coding approach was therefore that of conventional content analysis (Hsieh & Shannon, 2005). As is demonstrated by Figure 1 - Code development pareto analysis, new code development declined rapidly after six interviews, at which approximately 90% of codes had been developed.

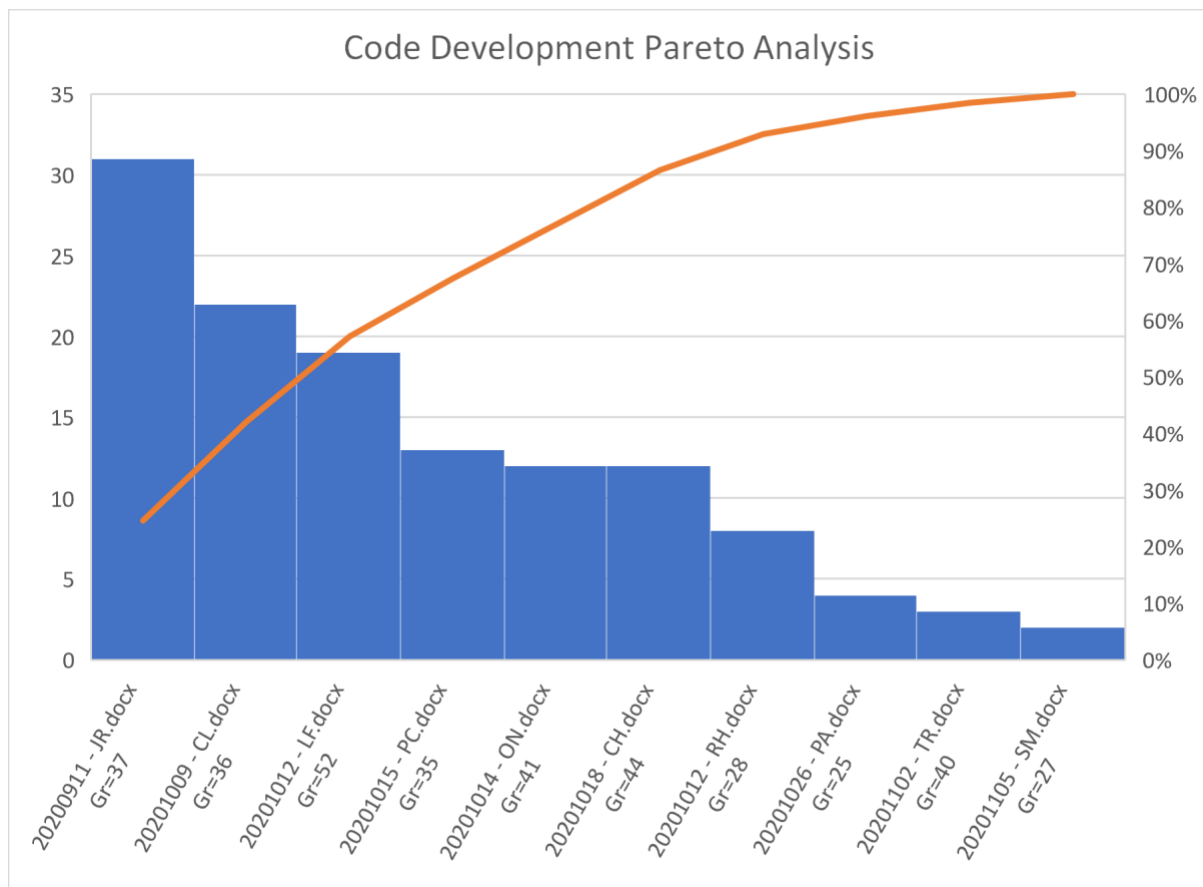


Figure 1 - Code development pareto analysis

From the 126 codes that were generated, these codes were categorised into 22 categories through an interpretation of the meaning in the codes, comparing and contrasting first within individual interviews and then across interviews, and from those categories seven themes emerged through the synthesis of the dynamic capability and digital transformation literature with the category and code development (Morse et al., 2002). The theme development was reviewed for consistency across individual interviews as well as across the three role types of interview candidates, CDOs, heads of digital and digital capability leads. The seven themes that emerged from the coding of the interview transcripts were: role dynamics, environment scanning, experimentation, digital strategy making, agile delivery, organisational change, and measurement, and can be viewed in Table 1 - Data analysis theme development.

Table 1 - Data analysis theme development

Role dynamics	Aspects pertaining to the creation of the role, the organizational parameters, and the background and experience of the respondents.
Digital strategy making	The nature of digital business strategy, the collaborative nature of digital business strategy development, and the role of the respondent in participating and shaping the process.
Environment scanning	Scanning capability of the organization's industry and the digital technology landscape for the identification of new opportunities in technology, process, or business model innovation.
Experimentation	Steps taken to introduce experimentation to evaluate and validate business ideas for inclusion in strategy making and execution.
Agile delivery	Agile delivery of digital transformation products, incorporating data, architecture and the burden of legacy IT and the need for two-speed ambidexterity.
Organisational change	The change required in individual mindset, organizational design, and organizational culture to complete and sustain the digital transformation.
Measurement	Expression of the need to measure every aspect of the digital transformation, digital product performance, and business performance internally and externally, and to report transparently.

The development of the codes, into categories, into themes, is can be viewed in more detail in Table 2 - Code development to categories and themes.

Table 2 - Code development to categories and themes

Code	Category	Theme
agile operating model	category: digital agility	theme: agile delivery
cross functional		
customer engagement		
speed to market		
data integration	category: digital architecture	
digital architecture		
digitisation vs digitalisation		
operational concerns		
two speed digital and IT	category: digital data	
data analytics		
data marketing		
data mass customisation		
data monetisation		
data privacy		
data quality		
data science		
data stewardship		
data strategy		
coordination	category: digital governance	
digital governance		
prioritisation		
digital delivery organisation		
business acumen	category: strategy advisory	theme: digital strategy making
business partnership		
digital advisory		
business ownership of digital strategy	category: strategy alignment	
digital business strategy		
transformation strategy		
transformation vision		
two speed digital and IT	category: strategy collaboration	
broad perspective		
business leadership		
leadership boardroom		
strategy collaboration		
business model		
efficiency		
consumer centriciy	category: customer research	theme: environment scanning
customer centricity		
entrepreneurial culture		
entrepreneurial leadership		

automation	category: digital research	
digital channel		
digital disruption		
market scanning		
platform network effect		
process digitalisation		
regulation		
continuous improvement		
curiosity		
customer enablement	category: customer orientation	theme: experimentation
customer centricity		
customer engagement		
design thinking		
lean startup	category: innovation ecosystem	
innovation		
innovation competition		
innovation everywhere		
innovation funding		
innovation labs		
innovation shortfall		
innovation with partners		
tech innovation	category: innovation enablers	
digital architecture		
digital governance		
digital labs		
digital tooling		
funding		
tooling to innovate		
capability development		theme: measurement
prototyping		
customer revenue		
demonstrate value		
kpi cost		
kpi customer satisfaction		
kpi disruption		
kpi ebitda		
kpi education		
kpi engagement		
kpi experiments		
kpi failures		
kpi people cost overheads		
kpi retention		
kpi revenue		
kpi scrum output		
kpi signups		
kpi standardisation		
kpi strategy influence		
kpi uptime		

measurement scorecard		
transparency		
culture change	category: change culture	theme: organisational change
digital culture		
business leadership	category: change leadership	
CEO leadership		
change_by example		
digital transformation leadership		
transformation vision		
adaptability	category: change mindset	
change collaboration		
humility		
individual mindset		
resilience		
change inertia	category: change organisation	
digital transformation		
organisation transformation		
agile operating model	category: change skills	
change education		
change empathy		
change listen		
change whats in it for me		
change_behaviour		
education		
integrity		
background	category: background	theme: role dynamics
entrepreneurial experience		
technology experience		
connector	category: personality	
future minded		
leadership		
leadership boardroom		
optimistic		
personality		
report to CDO	category: reporting lines	
report to CEO		
report to CIO		
report to COO		
report to CTO		
CDO failure	category: role creation	
CDO temporary		
creating the role		
first CDO		
first time CDO		
joint CIO and CDO		
role title		
qq		

3.7 Quality control and verification

The approach taken to quality control was pro-active and the researcher responsiveness, methodological coherence, sample appropriateness were designed into the process of inquiry (Morse et al., 2002). First, the researcher remained responsive to learning gained about the process of inquiry throughout. As the ongoing analysis continued, the data collection instrument was adjusted, and subsequent interviews were able to collect data with the benefit of the adjustment (Rowley, 2012). Secondly, the sample was developed in a structured and logical manner, identifying roles that were deemed to be appropriate as well as the mechanism of search for participants, which is believed to be replicable (Creswell et al., 2007). Saturation of codes, categories and themes developed indicate that the sample size was sufficient in size. Third, the data collection and data analysis activities occurred concurrently, if in batches rather than at each interview, allowing for reflexive adjustment to the data collection and data analysis process (Creswell et al., 2007). Lastly, through the iterative process of data analysis, and moving between macro- and micro-perspectives, the researcher attempted to ensure that the development of the theoretical outcome was achieved without making logical leaps (Morse et al., 2002). Despite these efforts to quality control and verification, limitations exist in the research.

3.8 Limitations of the research and opportunities for future research

The research study had several limitations, which in turn indicate opportunities for future research. The first limitation is the definition of the population. While the population was defined to allow for the inclusion of digital transformation leaders that did not have the explicit title of CDO, this may have dispersed the data collection, introducing concerns that are not those of true CDOs. Future research may apply a stricter definition of the population to ensure that there is no organisational variability introduced into the research, outside of how the CDO role is enacted, as existing research addresses organisational parameters as an influence on how the role is enacted (Horlacher et al., 2016; Singh et al., 2020). Secondly, in sampling from the population, the search mechanism of LinkedIn may have created a dependence on the social, professional, and academic networks of the researcher, as well as skewed the selection of the industries from which participants were selected. Future research may apply a more purposive approach to sampling from industries and organisations within those industries, as it has been shown that the starting point of the organisation and the industry,

and the dynamics of that industry, will define the urgency and nature of strategy by which digital transformation is pursued by the CDO (Hess et al., 2016). Lastly, the cross-sectional nature of this study, in the context of the nascent role of the CDO, limited insight into the developing digital maturity of the organisation and the ongoing role of the CDO in building the dynamic capabilities that enable it. To this end future research may apply a longitudinal approach to understand the progress toward the digital maturity of the organisation as orchestrated by the CDO.

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7 Appendix – Author guidelines of Business Horizons

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1. Double-space, use a 12 point font with normal text spacing, and one-inch margins throughout the entire manuscript. Manuscripts should not exceed 25 pages, all-inclusive. We cannot, however, consider notes, briefs, or commentaries. All pages, save the title page, should include pagination. Page numbers should appear centered at the bottom of each page.

2. The first page of the manuscript should include the title of the manuscript and complete contact information for each author with author name, affiliation, full postal mail address, email address, telephone number, and fax number. The corresponding author should be clearly noted in the case of multiple authors.

3. The second page of the manuscript should include the title of the manuscript, an abstract of 150 to 200 words, and four to five key words or short phrases that accurately reflect the content of the manuscript. Abstracts should be designed to provide a comprehensive executive summary of the manuscript in a manner that draws the reader's attention.

4. The body of the text should begin on the third manuscript page. The manuscript text should begin with an introductory heading.

5. Incorporate headings and sub-headings throughout the manuscript to aid readability. First order headings should be centered and all capital letters. Second order headings should be centered and use both upper and lower case letters. Headings should be descriptive and informative, yet not standard academic style. For example, rather than use "Introduction", you might elect to use "Corporate Women: Another Look". The aim is to guide the reader with innovative and lively language.

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Examples:

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Digital transformation: Five recommendations for the digitally conscious firm



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KEYWORDS

Digital transformation;
Digitization;
Digitalization;
Internet of Things;
Digital consciousness

Abstract Digital transformation is one of the key challenges facing contemporary businesses. The need to leverage digital technology to develop and implement new business models forces firms to reevaluate existing capabilities, structures, and culture in order to identify what technologies are relevant and how they will be enacted in organizational processes and business offerings. More often than not, these profound changes require firms to revisit old truths as they develop strategies that thread the needle between beneficial innovation and harmful disruption. This article uses the Internet of Things (IoT) as a backdrop to demonstrate the concerns associated with transformative technologies and offers five recommendations as to how firms can develop the strategies needed for digital transformation and become digitally conscious: (1) Start small and build on firsthand benefits; (2) team up and create competitive advantage from brand recognition; (3) engage in standardization efforts; (4) take responsibility for data ownership and ethics; and (5) own the change and ensure organization-wide commitment. As such, this article shows that digital transformation should be a top management priority and a defining trait of corporate business strategy, and that by becoming digitally conscious, firms may get a head start on their transformation journey.

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1. The challenge of digital transformation

Digital transformation is one of the key challenges facing businesses today. Miniaturization and the commercialization of mobile computing have made the essential building blocks smaller, cheaper, and more capable than ever (Saarikko,

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Westergren, & Blomquist, 2017). Indeed, one of the salient aspects of digital transformation is that access to the technology itself is rarely a problem. Instead, it is the ability to rapidly develop and implement viable digital business models that is at the heart of the issue (Hess, Matt, Benlian, & Wiesböck, 2016). In the words of Kane, Palmer, Phillips, Kiron, and Buckley (2015): "Strategy, not technology, drives digital transformation." This indicates that firms need to develop competencies in leveraging digital technology for business purposes. Developing such digital consciousness is the focus of this article.

The rate at which digital technology is able to spawn new "smart" products and services is matched only by its ability to extend the reach and range of social interactions via ubiquitous infrastructure and malleable platforms (Nambisan, Wright, & Feldman, 2019). Firms are feeling the pressure not just to alter their existing business models but also to operate a portfolio of different business models in order to cope with increasingly fickle customers who demand both flexibility and personalization of products and services (Li, 2018). But radically altering one's business model(s) and organization to leverage new technology is neither simple nor straightforward. It involves stepping out of one's comfort zone and possibly eliminating practices that employees and customers have come to expect or even take for granted.

Previous research has shown that digital transformation causes enterprises to rethink the very foundation of who and what they are. For instance, recent layoffs at General Motors were described as "existential," as the century-old Fortune 500 company was not merely responding to a periodic slump in sales but rather refocusing its whole organization to offer new digitized products and digitalized business models. This came with the realization that in the past 15 years there had been a consistent drop in the need for mechanical skills such as machine operating and tool grinding, while the demand for computer network-support specialists had skyrocketed (Muro & Maxim, 2018). Reassessing existing skills and capabilities and how they are combined is one way to transition from functional silos to cross-functional teams that can accommodate the interdisciplinary nature of innovative products and services (Porter & Heppelmann, 2015; Vial, 2019). But firms must also consider how new technology can create whole new value propositions and business models, and how it can transform not only how business is done but also what business is (Krotov, 2017). The ability to stay relevant and competitive in the wake of massive and rapid

technological development thus requires digitally conscious business strategies that thread the needle between purposeful development and tumultuous disruption.

This article builds on findings from three distinct types of firms—product-oriented, service-oriented, and technology-oriented firms—regarding their outlook on and experiences with the Internet of Things (IoT) and how it can be used to digitally transform their businesses. The IoT, with its ability to connect products, people, and places, is predicted to have a deep and profound impact on organizations. With the evolution of the IoT through the development of cloud computing, miniaturization, smart sensors, and mobile technology, objects can not only be identified and located but can collect, process, and transmit context-aware data through time and space (Greengard, 2015; Kortuem, Kawsar, Fitton, & Sundramoorthy, 2010; Lee & Lee, 2015). This in turn creates new opportunities for firms. A deeper understanding of a product in use can prevent costly unplanned stops and product failure, and it can enable the service organization to adapt its business model to the benefit of both the supplier and customer. With a connected product, a supplier can maintain regular contact with the customer without relying on extra time-consuming manual work, and the enhanced information may ultimately lead the firm to sell its product as a service or function rather than a piece of hardware. The IoT offers a wealth of new opportunities for the development of both products and services based on greater insight into individual customer needs and preferences (Brody & Pureswaran, 2015; Porter & Heppelmann, 2014) and can be used to improve both process efficiency and human productivity (Balakrishna, 2012). As such, we find it a current, relevant, and engaging technological paradigm that provides a context for exploring the digital transformation of firms.

Even though technical barriers have eroded away and the digital landscape has expanded with new possibilities, technology does not automatically bring added convenience or value unless firms carefully consider the context into which it is introduced and how to derive any practical or monetary benefits. Indeed, some refer to digitized products and services as "socio-cyber-physical offerings," highlighting that value is only extracted through a judicious intertwining of physical, technical, and social systems (Ng & Wakenshaw, 2017). Many organizations are still slow to embrace new possibilities, and those that do are faced with a new set of challenges in handling this complex landscape defined by both rapid technological

development and slower organizational processes (Matt, Hess, & Benlian, 2015). But the risks associated with inaction may be even higher, as history has shown that digital technologies in particular can topple industry giants who fail to change with the times (Nylén & Holmström, 2015). Previous research suggests that managers are often unaware of the different options and elements that they should take into consideration before diving headfirst into digital transformation (Hess et al., 2016). We propose that by becoming *digitally conscious*—that is, by developing an understanding of the opportunities, implications, and limitations in moving from a generic technological paradigm to a specific application, and by understanding how they are contingent upon concurrent social, cultural, and judicial systems—firms can become better equipped to take on new and transformative technologies. Set against the backdrop of the emerging IoT, this article provides an empirically grounded study of digital transformation and offers five recommendations for aspiring digitally conscious firms to consider as they embark on their digital transformation journeys.

2. Why digital technologies prompt transformation

It is widely recognized that as information is increasingly digitized and mobile devices accelerate in pervasiveness and processing power, an arena for innovation is opened up—one in which physical and digital components are combined (Porter & Heppelmann, 2014). Recent research (e.g., Henfridsson; Nandhakumar; Scarbrough, & Panourgias, 2018; Nambisan, 2017) has highlighted how the unique properties of digital technology enable new types of innovation and entrepreneurship that are different from the analog processes of the industrial era. Two distinctions are worth highlighting. First, digital technologies permit loose couplings between components, meaning that innovation is less restricted by existing architectural hierarchies and dependencies. Hence, any given technological baseline (e.g., a digitized product or digital system) can rapidly spawn several distinct offshoots of different types and purposes. Second, digital technologies are imbued with low barriers to entry, meaning that even small entrepreneurs have few restrictions to transforming innovative ideas to viable market offerings. These digital entrepreneurs can in some cases be disruptive to incumbents (e.g., the way ride-sharing services, such as Uber, have challenged the taxi industry).

The rapid pace of digital innovation is particularly challenging as firms design hybrid or smart products that incorporate digital components. Products equipped with smart sensors form interconnected systems that collect, store, and transmit data about the products and their environment to cloud servers or back-office systems (Baines & Lightfoot, 2013). Although some of the underlying technologies have been in use for a long time, with radio-frequency identification (RFID) tags being attached to everything from clothing and cars to animals and pharmaceuticals, their main purpose to date has been in identifying and tracking specific objects. Today, digital infrastructure extends all the way from back-office servers to frontline activities thanks to the development of cloud computing, mobile technology, middleware, miniaturization, and smart sensors. With the expanding IoT, objects can not only be identified and located but can collect, process, and transmit context-aware data through time and space, enabling new possibilities for product and service development (Lee & Lee, 2015). Virtually any occurrence can be digitized, analyzed, and monetized. Data collected from products in use make it possible for suppliers to efficiently monitor products and offer services after the sale. Suppliers can thus gain insight into where products are located, how they are used, and whether they are working optimally or in need of maintenance. If data from several connected products are combined, flows and processes can be analyzed to find patterns and behaviors. With developed algorithms, decisions can be made about how services should be performed or how processes should be optimized. The IoT thus enables the creation of situational, smart, attractive, and efficient goods and services.

Digital technology can be either transformative or disruptive depending on one's perspective and, more importantly, one's ability to harness its potential. It can either dislodge a firm from a competitive market position or serve to improve operational efficiency, empower frontline employees, inspire new market offerings, or indeed create entirely new industry niches. But this potential will not come to pass without a thorough understanding of digital technology in itself and just how it is relevant to a firm's own specific circumstances. Any firm seeking to make hay of digital technology must be willing to adapt its strategies and capabilities to accommodate new ways of perceiving and creating value. As an initial step, firms must better understand digital transformation and recognize that it is not a homogeneous concept.

3. Digital domains: Digitization, digitalization, and digital transformation

As digital technology diffuses into industry, the economy, and society, it becomes increasingly necessary to distinguish between the different phenomena that emerge where the physical and virtual worlds intersect. At a bare minimum, one needs to differentiate between *digitization*, *digitalization*, and *digital transformation*, as well as what they signify in terms of scale and scope. Figure 1 shows how the three domains relate to one another, with digitization as a component of digitalization—which, in turn, is subsumed under digital transformation.

Digitization is the technical process of converting analogue signals to digital signals (Tilson, Lyytinen, & Sørensen, 2010). This process permits the decoupling of form, function, and access, and it is a fundamental precondition for everything from smartphones to artificial intelligence. The way we access music provides us with a simple yet illustrative example of the power of digitization. As long as music is stored in an analog format (e.g., on a vinyl record), there are tight couplings between form, function, and access. That is, one cannot easily separate the data (the music) from the medium (the record), and it can only be accessed using a specific technology (a record player). But when music is digitized, it may be distributed in different formats (e.g., MP3, FLAC) using different media (e.g., physical disc, online streaming), and it may be accessed via multiple devices (e.g., CD player, computer, smartphone). While the aforementioned example of music describes the transition from analogue to digital information, digitization also encompasses how one captures physical activities and converts them into virtual representations. This form of digitization affords products and devices the ability to capture

and convey location, velocity, temperature, humidity, vibrations, and other measurements as digitized data. When coupled with powerful algorithms, these data are essential to today's smart products that operate autonomously or with remote supervision (Porter & Heppelmann, 2014). While the task of digitization is a complicated process that requires technical expertise, it can largely be outsourced or managed by a relatively small group of experts, and it is thus insulated from other aspects of an organization.

Digitalization is the sociotechnical process of leveraging digitized products or systems to develop new organizational procedures, business models, or commercial offerings (Brynjolfsson & McAfee, 2014). While the words "digitization" and "digitalization" are often used interchangeably, there are important conceptual differences. Whereas digitization describes a technology—or system of technologies—in terms of what it is and its capabilities, digitalization answers why this technology is relevant to a specific process or organization. Returning to music as an example, the separation of content and medium has enabled iTunes and Spotify to redefine how we access and consume audio entertainment. Moreover, streaming audio services have redefined the underlying business model by changing the manner in which performers, producers, and distributors are compensated. Digitalization also affects how we use physical products—for instance, in the so-called sharing economy, multiple users can access and use the same product, thus shifting the nature of business from product retail to product access (Kathan, Matzler, & Veider, 2016). Industrial machinery is undergoing a similar transition, with suppliers keen to offer all-inclusive service contracts so that customers pay per product use rather than product purchase. Digitized machinery makes this digitalized business model more appealing to suppliers, who can easily supervise their products in the field, reducing the risk entailed by their responsibility for continuous performance. Furthermore, they can monitor machine conditions and dispatch technicians to perform predictive maintenance before costly breakdowns occur (Saarikko et al., 2017). Digitalization is difficult to insulate from the enterprise at large, as it directly, and often profoundly, affects organizational processes and business models. New contracts based on service provision rather than product retail may also harm customer relations. The effects can, however, be mitigated so as not to affect or displace core competencies. A car manufacturer will still need to know how to

Figure 1. Digital domains

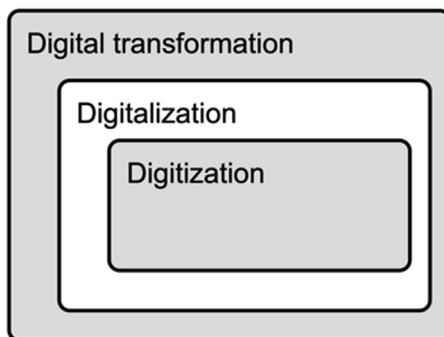


Table 1. Study participants

Type of firm	Name of firm	Industry	Role of respondent
Product-oriented	P01	Heavy machinery	Responsible for IoT solutions
			Responsible for service development
			Division manager, IT
	P02	Heavy machinery	After-sales manager
			Division manager, IT
	P03	Professional appliances	Division manager
			After-sales manager
	P04	Professional appliances	Responsible for IoT solutions
Service-oriented	S01	Facility management	Innovation manager
	S02	Payment solutions	CTO
	S03	Transportation	Manager IoT solutions
	S04	Resort management	CIO
	S05	Facility management	IoT strategist
	S06	Facility management	Systems technician
Technology-oriented	T01	Telecommunications	IoT business developer
	T02	Connectivity and cloud solutions	CEO
			CTO
	T03	Connectivity and cloud solutions	CEO
	T04	Connectivity and cloud solutions	CEO
	T05	Smart sensors	CTO
	T06	Smart sensors	CTO
	T07	Smart sensors	CTO
	T08	Interface design	CEO

build cars regardless of whether they are sold, leased, or shared in a pool.

Digital transformation is the sociocultural process of adapting firms to the new organizational forms and skill sets needed to remain viable and relevant in a digital landscape. It goes beyond earlier conceptions such as change enabled through information technology (IT) (Benjamin & Levinson, 1993) or through business-process reengineering (Grover, Jeong, Kettinger, & Teng, 1995), which seek to improve upon existing processes. Rather, digital transformation may be described as a “process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies” (Vial, 2019, p. 121). The use of the word “culture” is by no means hyperbolic. A survey of digital maturity including some 4,800 business executives found attitude rather than access to technology to be the decisive factor, highlighting that “[a] culture conducive to digital transformation is a

hallmark of maturing companies” (Kane et al., 2015, p. 9). The different ways in which digital technology is perceived to create value resonate deeply with previous research that showed how the value of IT is realized in economic gains, process improvements, and enhancements to the brand name that tie customers more closely to the firm (Kohli & Grover, 2008). That is, much of the focus has been on how the customer-provider dyad can be developed and strengthened. But recent research has also demonstrated that cutting-edge amalgams of physical products and digital resources, such as the IoT (Saarikko et al., 2017), artificial intelligence (Kaplan & Haenlein, 2019), and machine learning (McAfee & Brynjolfsson, 2017), are complex phenomena requiring new intellectual resources that are often beyond the capabilities of any one firm. Hence, in addition to significant changes to the internal workings of firms, digital transformation also pushes innovation beyond organizational boundaries into external innovation networks (Prince, Barrett, &

Oborn, 2014; Westergren, Holmström, & Mathiassen, 2019) or ecosystems (Jacobides, Cennamo, & Gawer, 2018; Rong, Hu, Lin, Shi, & Guo, 2015).

The three digital domains may seem straightforward at first glance, but they all hide layers of complexity amid their implications for value creation, technology management, business strategy, and organizational culture. This article builds on an empirical study of firms and their attempts to make sense of digital transformation as new technology investments bring their digital concerns from back-office IT departments to executive boardrooms as well as frontline operations.

4. Interviews

The authors performed interviews with firms in various stages of digital transformation as they implemented IoT devices into their business models. We conducted semistructured interviews with 23 representatives from 18 firms that differed in size, industry, and market offering. The respondents were all involved in their respective firms' IoT adoption and implementation processes, and were either C-level management themselves, or reported directly to CIOs or CTOs. Table 1 gives an overview of our data set. The interviews lasted from 30 minutes to 90 minutes and averaged 45 minutes. All interviews were recorded and then transcribed. Furthermore, six firms demonstrated their IoT-based systems, which gave us a deeper understanding of how different technologies and data sources interact to create smart solutions and machine learning that provide benefits for providers as well as customers. Finally, company websites and documentation provided by respondents provided additional contextual information pertaining to each enterprise and its domain.

We performed the data analysis in two stages using ATLAS.ti software. First, we performed an in-case analysis for each firm (Eisenhardt, 1989), in which we searched for patterns and repeated statements in the data to gain insights into the specific firms. Previous research has shown that there are three basic types of firms within IoT ecosystems: product-, service-, and technology-oriented firms (Burkitt, 2014; Saarikko et al., 2017). At this stage of the analysis, we therefore categorized each firm into one of these three types. In the second stage, we searched for common patterns and divergent stances between and within the three different types of firms. By applying multiple lenses and moving back and forth from specific firms to collective insights, we

avoided settling for initial impressions and were able to stay close to the data. Our conclusions are drawn from the synthesis of the data analysis and the literature. Some specific quotes from the interviews are used to highlight certain details, and all company names have been anonymized in order to protect privacy.

5. Voices from the field

The IoT is a suitable empirical context in which to study digital transformation, as it marks a new technological paradigm that disrupts organizations and markets (Krotov, 2017; Porter & Heppelmann, 2015), forcing firms to revisit old truths and acquire new capabilities. IoT solutions require several distinct skill sets that, at a minimum, pertain to product design and manufacturing, service development, and connectivity and IT infrastructure (Saarikko et al., 2017). The firms in our study belong to one of three categories: product-oriented firms, whose main business has been delivering specific products for either a business or consumer market; service-oriented firms, whose main business has been service provision to other business and to consumers; and technology-oriented firms, which create connected devices, sensors, and other technology that enable connectivity and collection of data. All of the firms had implemented various IoT solutions into their business practices and were busy working on their strategies for digital transformation in order to fully take advantage of the opportunities afforded by new technological developments.

5.1. Product-oriented firms

The product-oriented firms included in this study are all large, firmly established enterprises that dwell within a single industry or a limited number of industries. Their long-standing history within said industries is reflected in their respective skill sets: They are exceedingly adept at what they have been doing for decades. Furthermore, they have had little incentive to do anything else, as they have operated in industries and markets that have been reluctant to embrace major change.

The advent of disruptive technologies such as IoT has disturbed this rather comfortable status quo. Third-party providers that are wholly unaffiliated with manufacturing firms have started retrofitting products with remote connectivity in order to enable services that range from basic GPS positioning and fuel-efficiency algorithms to advanced systems that combine multiple data

sources, such as position, weather, time, and temperature. This is particularly salient for P1, P2, and P4, who have seen this phenomenon gain momentum for several years. The result of this development is twofold. First, it has transferred some of the market influence away from the product provider and into the hands of the customer. As third-party solutions are brand-agnostic, customers are able to apply the same solutions and services across their entire inventory of equipment or fleet of vehicles irrespective of manufacturer. Second, the appearance and proliferation of third-party solutions clearly indicate a change in the business climate for which the manufacturers themselves are ill prepared. There are evidently opportunities for new business models—and thus for profits to go into someone else's pockets. We were able to discern two distinct attitudes toward this phenomenon. P1 and P2 were quite restrictive and exhibited a possessive attitude toward the data generated by their products, whereas P4 was considerably more open to including other parties.

We don't want people tinkering with our products, and it would be better if third-party firms found different niches ... It could be that they focus on a particular market segment and build systems for that type of users, and utilize the APIs that we provide and pay a license fee to us. [P1, responsible for IoT solutions]

It's entirely possible that service-oriented firms can access data and monopolize product-related service development. We as product-providers consider that scenario as well. So we're looking at competition or cooperation. I think that the only way to success here is cooperation between product manufacturers and suppliers of service and support. We simply have to realize that we have to let everyone get a piece of the pie. If not, we're going to get in each other's way and that's not the way forward. [P4, responsible for IoT solutions]

In essence, mature product-oriented firms consider themselves at risk of getting demoted from trusted partners to mere providers of hardware. The prospect is not at all appealing, as all the product-oriented firms featured in our study are premium brands that strive to compete through quality and reliability rather than mere retail price. Moreover, they have all developed extensive in-house capabilities and dedicated

departments to handle product R&D and similar critical activities. Activities less related to brand identity but important to production and retail are managed through long value chains populated by trusted suppliers and contractors. While this operational necessity can be a potent barrier to entry for direct competitors, the same value chains can also shackle firms to a particular mindset that is focused on streamlining rather than innovation. The legacy of closed systems and in-house development that once was a source of leverage can suddenly become a drawback as customers start demanding something different.

It's typical of old companies built by engineers that you think your way is the right way. But at the same time, our products do contain an assortment of components built by other suppliers. So it's really not in our nature to do everything by ourselves. By the typical approach, as you've seen if you study different manufacturers, is to try do it yourself at first. [P4, responsible for IoT solutions]

There is, however, one significant point on which all product-oriented firms agree: They are all sanguine about furnishing their products with remote connectivity, as hard data helps to justify high retail prices. If they can show that their products are more dependable thanks in part to smart services, then they will have an easier time justifying their higher retail price relative to cheaper alternatives. The idea of backing up qualitative claims with quantitative data feeds into the idea of strengthening the brand and forming a closer relationship with the customer. Furthermore, if a firm's product leaves the factory with remote connectivity already installed, it can eliminate or severely limit the appeal of retrofitted solutions, as they become effectively redundant. But while all the firms included in our study have begun incorporating the appropriate hardware for remote supervision, they have yet to match the more advanced services offered by the aforementioned third-party solutions. Thus far, their core service offerings amount to detection of anomalies—for example, cases of product breakdown, misuse, or theft.

We gather a whole lot of data, really. We don't actually use it anywhere near as much as we could. But we're trying to become smarter and smarter. So just like you said, we try to see if the driver's doing something strange, or if the machinery is somehow acting up. [P2, division manager, IT]

One issue that has yet to be resolved pertains to the ownership of said data. On this particular issue, P1, P2, and P3 hold a somewhat possessive stance, either claiming data ownership or explicitly asserting the right to access product data whenever customers enter into service contracts. P4 maintains that data ownership per se should not be a priority; rather, the priority should be to ensure that information is accessible to multiple actors so that the product is compatible with different business models (e.g., leasing and direct retail) and different types of customers (e.g., business-to-business or business-to-consumer).

5.2. Service-oriented firms

The service-oriented firms included in our study were more positive toward the IoT as a general trend because they have no vested interests in any particular products. But all six firms agreed regarding the main barrier to widespread adoption: the overall lack of common standards and interoperable systems. S2 and S4 face the most severe restrictions: S2 wrestles with a patchwork of legacy banking systems, while S4 faces safety regulations and certifications that prohibit even the most basic integration between systems at their resorts. The remaining firms are less confined by their business contexts but must still contend with significant technical hurdles. The lack of common standards or application programming interfaces often requires case-by-case integration between different systems and technologies, which can entail high risk and first-mover costs. Several of the service-oriented firms included in our study, most notably S1 and S3, operate in market segments that offer low profit margins. Hence, these firms seldom undertake any investment (IoT-related or otherwise) unless they can be certain that it will yield tangible returns in the form of reduced operating costs or a competitive edge.

We see an incredible range of possibilities with IoT. The current limitation is basically to get a hold of a horizontal platform [that can handle multiple systems]. Alternatively, there are a lot of different systems in the market these days, but individually they do not provide the overall benefit needed to outweigh the costs of managing and supporting multiple systems. [S1, innovation manager]

Due to the nature of their businesses, service-oriented firms are keen to derive operational

benefits from using smart technology in service provision. The service industry is labor-intensive, with service staff performing all manner of tasks that cannot be automated. While a personalized touch is part of service provision, firms spend a significant amount of time and effort checking whether service is actually needed. Leveraging advanced algorithms and learning systems to analyze sensor data would permit these firms to maintain or even improve upon current service levels at lower costs. For instance, S1 and S6, who are both within facility management, see significant potential for process improvement if they can perform service tasks when and where they are actually needed, as opposed to scheduling tasks based on their best guesses. S5 describes how a single sensor installed on the roof of a building can provide automated updates regarding external conditions, enabling a wealth of useful insights:

What we're doing now is installing snow-sensors onto rooftops. Sending an engineer with a five-year college degree up to check the amount of snow on the rooftop is going to be pretty expensive, so we thought that 'we'll install an automated sensor instead, and it will gauge the snow depth' ... You can also look at development over time, for instance 'hold on — if it's three degrees below freezing and I had three feet of snow on my roof, and now two days later it's only two feet of snow. What's going on?' Well, it's likely that your roof is poorly insulated and is venting heat. Following that, you can immediately ask yourself 'where did the snow that melted go? Are there pools of water sitting on my roof, or do I need to worry about icicles hanging off the sides?' So, just by measuring snow depth, you can find out all kinds of things that you didn't know. [S5, IoT strategist]

Although recent technical advances have ignited much interest in connecting products to the internet or outfitting buildings with smart sensors, the service industry has been using some of the technologies associated with the IoT (e.g., RFID tags) for many years. But the proliferation of smart sensors necessitates a different approach, as it would be unethical to deploy sensors that continuously gather data on the activities of specific individuals without their consent. Furthermore, the legal frameworks that govern these types of surveillance are not yet mature and are subject to change based on political discourse or public concern. The service providers included in our

Table 2. Summary of results

Digital domain	Digital concerns	Empirical findings
Digitization	Incremental changes	Minor digital features are introduced in new offerings in order to give the appearance of novelty.
	Data as persistent resource	Extracted data can be used for multiple purposes and on multiple occasions.
	Necessity of partnerships	Cutting-edge capabilities can be acquired more quickly and easily through partnerships with external organizations.
	Lack of standards	The lack of agreed-upon standards serves to inhibit uptake of new technologies, as each actor has to spend time and resources solving basic interoperability issues.
	Data hoarding	Large quantities of data are gathered and stored without a clear understanding of their purpose or value.
Digitalization	Business-model modification	The influx of new technologies provokes shallow or profound adjustments to the firm's business model.
	Business myopia	An inability to develop new business models and revenue streams based on data.
	Digital newcomers	Stable market structures are disrupted by new entrants who leverage digital technology to appropriate unexplored business opportunities.
	Spectrum of improvements	Digital technology offers many distinct opportunities, ranging from minor improvements to major reengineering, benefitting frontline employees or centralized management.
	Value-chain inertia	Mature firms accustomed to working with linear value chains have difficulty adapting to ecosystems and cocreation often found in digital economies.
Digital transformation	Lack of clear vision	New technology is introduced on a case-by-case basis without a long-term strategy.
	Customer expectations	New technology is introduced because of external pressure rather than internal strategy.
	Outcome ambiguity	Actors are reluctant to enact transformative change, as it is perceived to be a gargantuan, long-term project with uncertain outcomes.
	Familiarity over innovation	Significant innovations and departures from the status quo are easier to accept from mature, established actors than from niche firms, even though the latter often offer more advanced solutions.
	Sociotechnical misalignment	Technological development far outpaces other aspects of society, leading to a fundamental mismatch between what technology permits us to do and our ability to grasp its consequences.
	Cultural inertia	Mature firms are often reluctant to engage in partnerships or look outside their own circles for new capabilities.

study were all very clear that they did not want to bear the risk of violating current or future laws by recording personal data—nor do they want to shoulder the responsibility for warding off unauthorized access to sensors for illicit surveillance. Their response to this issue is to use sensors that are deliberately unspecific; for example, a sensor may be able to register movement but not a person's height, weight, or other distinguishing features. Even when user data is anonymized and reduced to numbers in a system, service providers offer quite different perspectives on how they

would like to leverage said data. S1 and S6 are relatively homogeneous enterprises where similar, often-routine tasks are performed by different staff in different locations. Consequently, these enterprises see the value of a "dashboard" of sorts that can provide a quick overview and status updates from a central office. In time, machine learning and automated responses may reduce the need to manually assess and respond to routine operations. On the other hand, S4 is a considerably more heterogeneous organization that considers IoT and smart sensors a way to empower frontline

employees in their respective tasks. When coupled with algorithms that can identify clusters and bottlenecks, sensor data may be useful for S4's long-term planning—for example, by ensuring that the most heavily trafficked areas are equipped with adequate restrooms and similar essential facilities.

5.3. Technology-oriented firms

All the technology-oriented firms featured in this study—with the notable exception of T1—are small or medium enterprises. They differ significantly in orientation and occupy different niches that collectively make up the requisite technologies to enact digitized products and digitalized business models. T1 provides the information infrastructure (e.g., 4G communications networks) that is needed to transmit data from remote locations. T2, T3, and T4 design cloud solutions that can accommodate robust connectivity and handle the massive quantities of data generated by connected devices. T5, T6, and T7 design sensors for deployment in an array of environments, from modern office spaces to mine shafts. Finally, T8 aggregates data and produces interfaces that suit the needs of different user groups.

While the recent surge in interest surrounding the IoT has forced product and service providers to stop and consider their options, the technology-oriented firms featured in our study are cautiously optimistic. One recurring theme among all these firms was the emergence of new opportunities to apply existing skill sets in new industries and market spaces. T4 provides an illustrative example. The firm used to develop and manage systems for online gambling, and in doing so, it learned to build scalable back-office systems, handle payment systems that can accommodate multiple currencies, and develop intuitive user interfaces. Today, the very same skills are invaluable in building a platform that can collect and analyze data from a steadily rising number of connected units without causing system instability or requiring a proportional increase in support staff.

We learned a lot about designing systems that are scalable and secure, the ability to process different currencies, and to design user interfaces ... Almost by accident, we ended up consulting for [a product manufacturer] as they were designing an online-feature of their own. [...]IoT wasn't really the widely used expression back then, and we realized that we were one of few

companies that had actually produced something tangible. [T4, CEO]

Even though most of these technology-oriented firms can be described as mature (all but T4 have been around for 10 years or more), very few of them have attained any significant brand recognition. The exception is T1, which is a large enterprise with a familiar brand. The disconnect between technical proficiency and brand recognition is a significant factor for many tech-savvy small and medium enterprises. Prospective customers are hesitant to adopt a technology that they do not fully comprehend, and they are even less inclined to accept an offer from an unfamiliar firm. As such, technology-oriented firms are keen to engage in partnerships or participate in ecosystems backed by larger, more familiar firms.

Unlike the product and service providers we studied, the technology-oriented firms expressed no real interest in owning or accessing customer data. While they acknowledge that it is well within their capability to store data generated by customers, they generally prefer to position themselves as impartial and as sources of customer empowerment, not exploitation. As such, technology firms make an explicit distinction between the act of gathering and forwarding data in real time, and the process of analyzing data to discern patterns or long-term trends, even though both activities are enabled by the same technology. A couple of the firms we studied, T2 and T5, went so far as to claim that they absolutely do not want to be responsible for storing or managing customer data. Their role is only to process and forward data in a manner specified by the customer.

5.4. Summary of case findings

As our study includes firms that differ in orientation as well as in size and scope, it naturally follows that they represent a wide range of conditions, perspectives, interests, and ambitions. The empirical findings can for analytical purposes be separated and attributed to the domains of digitization, digitalization and digital transformation. A summary of the results is provided in [Table 2](#).

Our study reveals a number of challenges related to business strategy (e.g., changing business models and threats from newcomers) and technical issues (e.g., standardization and aimless data hoarding), as well as distinctly “soft” issues stemming from industry norms and corporate culture. The common theme is the general perception of digital technology as a disruptive force that

some perceive as a catalyst for opportunity, while others see risks stemming from the scope and uncertainty associated with transformative change. Both perspectives derive from the peculiar nature of digitized data as an ephemeral yet reusable and infinitely renewable resource that has changed—and continues to change—how we conduct business. The effects range from minor tweaks and improvements to existing processes to profound changes to the very essence of business models—for example, changing market offerings from retail products to providing a service or function.

6. Five recommendations for becoming digitally conscious

Digital transformation often pushes enterprises out of their comfort zones by forcing long-term strategic choices about an unpredictable future (Nylén & Holmström, 2015). On the basis of our empirical findings and a review of extant research, we present five recommendations for developing digital consciousness within firms that are engaged in digital transformation.

6.1. Start small and build on firsthand benefits

Digital transformation is a comprehensive term that describes the ability of an organization to leverage digital technology to improve the efficiency and efficacy of its internal operations and external market offerings (Vial, 2019). As such, digital transformation is prone to being associated with paradigm-shifting technologies such as artificial intelligence, machine learning, or big data, all of which require significant up-front investments in time, money, and staff before any significant benefits can be realized (Lee, 2017; McAfee & Brynjolfsson, 2017).

In this article, we describe digital transformation as a sociocultural process rather than as a technical feat. That is not to say that technology is unimportant, but rather that the drivers of transformation are organizational culture and ideas rather than technological savviness. The service-oriented firm that installed sensors on rooftops to measure snow depth speaks to our point in that the technical solution is often simple. Aggregating the data from a handful of sensors across different buildings does not require advanced databases or analytical support; it can quite easily be monitored by either a local building manager or a facility management office.

The transformative aspect is not expressed in the technical artifact itself but rather in the insight needed to identify the benefits that can be derived from using a digital tool to solve a business problem. Moreover, a defining characteristic of digital technology is the ability to increase the density of information and the knowledge resources that may be brought to bear on any single set of data (Lusch & Nambisan, 2015). That is, any phenomenon that may be represented by bits and bytes can instantaneously be transported across vast distances and analyzed by someone with an entirely different perspective and set of experiences. An additional transformative property of the digitally conscious firm is the ability to realize this potential and to treat data as an interdisciplinary resource that is not consumed upon use but that can be leveraged to extract multiple benefits depending on context. Hence, the name of the game is not to indiscriminately gather big data but rather to carefully gather the right data for the firm's needs and to build on the benefits that they bring.

6.2. Team up and create competitive advantage from brand recognition

The digitization of the physical world holds much untapped business potential (Brynjolfsson & McAfee, 2014). Even so, its practical implementations are in many regards still considered a relative novelty within many market segments and industries. Even if the underlying technology is mature and robust, it still carries with it a perceived risk within established firms, as the more innovative solutions often come from small tech firms and entrepreneurs, which are more agile. While extant research has highlighted how judicious use of IT can enhance a company's brand name (Kohli & Grover, 2008), our study suggests that a strong brand name is a prerequisite for engaging customers in transformative efforts, innovative business models, and new market offerings. That is, firms that already have a strong brand name have a head start when it comes to incorporating connected products or machine learning into their business, thanks to their installed customer bases and high credibility in their fields. Participation in an ecosystem may serve to mitigate risk and to create a win-win situation, whereby established firms get fast access to technological know-how and new business models, while small tech firms with less familiar brands may make use of their partners' strength to establish a foothold from which to gradually build their own credibility and to scale up their

offerings. An established brand is indeed a powerful resource in the face of the risks and uncertainties that come with new technologies and market offerings. But there are limits to how far you can stretch customer loyalty and patience. Product-oriented firms are especially vulnerable to inaction and failure to move with the times. Impatient customers may start looking for workarounds and third-party options if brand-sanctioned, first-party solutions fail to materialize within an acceptable time frame. In the end, failure to move with the times may serve to devalue the brand and to pave the way for new, IT-literate competitors, just as the conservative automotive industry did for Tesla.

6.3. Engage in standardization efforts

Digital innovation is based on the ability to combine a large number of digitized technologies that are, when viewed in isolation, relatively mature and easy to deploy. But in practice, things are rarely so simple. Digital transformation relies on an organization's capability to acquire, deploy, and maintain several distinct technologies in parallel without becoming overwhelmed. The IoT illustrates the point, in that a hierarchy of technologies need to work together, from the smallest sensor or RFID tag to large cloud servers and back-office systems (Borgia, 2014). Connecting a wide variety of technologies may bring about a patchwork wherein individual integrations are sound and sensible, but they can be difficult to oversee or stress-test due to the sheer size of the system and the scope of its implementations. Moreover, technical infrastructures and new market offerings are increasingly developed through partnerships or in ecosystems, further stressing the sociocultural nature of digital transformation. This gives rise to diverging and often conflicting strategic interests of different firm types (Saarikko et al., 2017). Technology-oriented firms want their offerings to be applicable to a range of different firms and industries. Product-oriented firms, on the other hand, are more interested in distributing IoT solutions as part of their own line of products in hopes of enticing customers to opt for multiple, technically compatible products from the same supplier. If different enterprises pool their intellectual and material resources, they can begin to develop standards and interfaces that may become widespread within an industry or market. In time, standards can disseminate into other contexts as well, accumulating legitimacy and strength along the way. We may draw comparisons to the internet, which gradually grew through small, incremental

additions and improvements by independent stakeholders into the global network that we see today. Given the pervasive and enduring influence of standards, the digitally conscious firm should ensure that their interests are reflected in standards' development and enactment. Otherwise, they may find themselves out of the loop and working in a technological landscape that runs counter to their strategic interests, as when customers began retrofitting vehicles with third-party solutions over which the vehicle providers had no influence or control. Hence, standardization is not merely a matter for the engineering department; it also has a significant strategic component that should attract the attention of corporate management.

6.4. Take responsibility for data ownership and ethics

While the wholesale creation of data is not the key defining feature of digital transformation, it is an inescapable consequence of working with digitized products and digitalized business models. With thousands or millions of connected products, firms have a golden opportunity not only to provide connectivity solutions but also to capture a bigger part of a market, one that increasingly derives its revenues from services based on collected data. Because digitized products and services can be used for business and consumer purposes simultaneously, firms have every opportunity to create win-win solutions that cater to both sides and generate multiple types of value. One of the unanswered questions of digital transformation is where to draw the line. Smart products and connected environments are capable of gathering a significant amount of data on individuals. While single data points may be harmless, the routine gathering of data from multiple sources and the compiling of detailed digital profiles on people, whether customers or employees, have troubling implications (Weinberg, Milne, Andonova, & Hajjat, 2015).

The ethical quandary is twofold. First, while individuals may consent to sharing individual scraps of information about themselves with organizations with which they interact, this does not entitle any one actor to combine data from various firms or to compile a comprehensive image of consumers' activities. Second, such information has considerable destructive potential should it fall into the wrong hands. An increased awareness of the responsibilities of data management is a watershed with regard to a firm's digital maturity. While some actors are eager to gather as much data as they can, we note that the more technology-savvy firms are notably less keen to

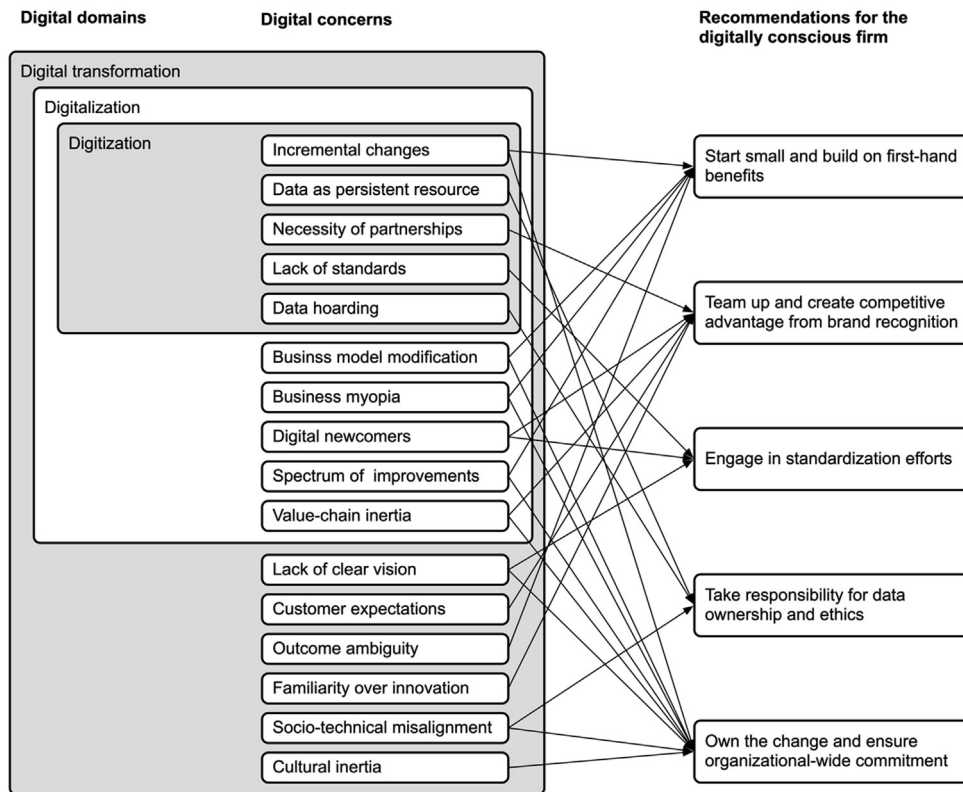
assume ownership and responsibility for user data. While they identify real-time data capture and long-term data analysis as two separate values enabled by the same technology, they are hesitant to embrace the latter. They do not want to get embroiled in the legal hassles and responsibilities that come with data ownership, preferring to transfer accountability to someone else. Ng and Wakenshaw (2017) used the term “socio-cyber-physical offerings” to describe digitized offerings and digitalized business models. Our study suggests that successful digital transformation requires recognition of the legal dimension, leaving us with the cumbersome label of socio-cyber-physical-*juridical* offerings. Hence, digital transformation entails careful consideration of the legal and practical implications of data ownership and management.

6.5. Own the change and ensure organization-wide commitment

Previous research has shown that digital technology creates both tangible and intangible value (Nambisan, 2013). But in the context of digital

transformation, value is only extracted through a conscious and deliberate entanglement of physical, technical, and social systems (Ng & Wakenshaw, 2017). As the survey by Kane et al. (2015) demonstrates, corporate culture is a significant component in embracing and exploiting digital technology in transformative efforts. The firms in our study perceived digital transformation as a significant departure from current practices and were very aware of the risk of cultural inertia and sociotechnical misalignment stemming from misconceptions of what the technology could and would do. They stressed the importance of ensuring organization-wide commitment and of making sure technological development is grounded in both strategy and practice. By implementing IoT solutions, they came to see the possibility of breaking with tradition and of moving from linear value chains to value networks. Such a move, however, entails having a clear vision and taking into consideration the idiosyncratic nature of each firm, including current corporate practices, norms, and business values. Furthermore, it requires leadership and endorsement from top management. Ultimately, we have seen that

Figure 2. Digital domains and becoming digitally conscious



digital changes to the organization, its business practices, or its products and services cannot be ends unto themselves but must be means to an end. To reduce outcome ambiguity, digital-transformation efforts must be established by top management, firmly entrenched in middle and lower management, and allowed to permeate all aspects of organizational life. Raising the level of digital consciousness can thereby produce substantial improvement in the firm's ability to leverage digital technology and own the change.

6.6. The five recommendations

Digital transformation is a complex phenomenon encompassing different types of technologies, firms, and management strategies. Our five recommendations for becoming digitally conscious are inextricably linked in practice. As such, they cut across all three domains: digitization, digitalization, and digital transformation. Figure 2 shows the linkages between digital domains, digital concerns, and the five recommendations.

7. Conclusion

Embracing digital transformation requires firms to identify what technologies are relevant and how they will be enacted in business offerings. As digital technology burrows deeper into organizational processes and market offerings, it will inevitably affect business strategies as firms reevaluate their perceptions of themselves as well as their relationships with partners and customers. In this article, we have used the IoT to illustrate the risks and potential of new, potentially disruptive technologies, and we have empirically explored firms' conceptions of digital transformation. Based on our research, we offer five recommendations for firms to consider when formulating digitally conscious strategies that combine technological advancements with business practice and organizational culture:

1. Start small and build on firsthand benefits.
2. Team up and create competitive advantage from brand recognition.
3. Engage in standardization efforts.
4. Take responsibility for data ownership and ethics.
5. Own the change and ensure organization-wide commitment.

In so doing, we have shown that developing digital consciousness and embracing digital transformation requires taking into account social, technical, and organizational factors and firmly grounding them in both strategy and practice. These five recommendations are inclusive but not exhaustive. Future research should therefore elaborate on the opportunities and challenges of digital transformation across different firm types and within different technological paradigms.

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9 Appendix – Interview guide

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Semi-structured in-depth interview guide

Interview Guide		
Number	Question	Probing questions and keywords
	<p>Warm up with some introductions and small talk.</p> <p>Ensure that the Informed Consent form is signed.</p> <p>Verify that the interview can be recorded.</p> <p>Start recording.</p> <p>Start off easy.</p>	
Q1	Tell me about how you came to be appointed as the CDO at your organisation	<p>Existence of the role</p> <p>Previous experience as a CDO</p> <p>Reporting lines</p>
Q2	Tell me about the main expectations of you in your role as CDO	<p>Setting of strategy</p> <p>Leading initiatives</p> <p>Measurement of success</p> <p>Organisation</p> <p>Financial responsibilities</p>
Q3	Tell me about your role in identifying new opportunities for your organisation and how your organisation is set up to identify new opportunities	<p>Scanning for trends</p> <p>Seeing opportunities</p> <p>Engaging with customers</p> <p>Role of data</p> <p>Organisation and routines</p> <p>Innovation and experimentation</p>
Q4	Tell me about your role in acting on those opportunities and you're your organisation is set up to act on new opportunities that have been identified.	<p>Measurement of success</p> <p>Cross-functional engagement</p> <p>New business models</p> <p>Methodologies</p> <p>Organisation and routines</p>
Q5	Tell me about your role in the on-going transformation of your organisation	<p>Alignment to vision</p> <p>Culture</p> <p>Change management</p> <p>Transformation of organisation</p> <p>Charisma</p> <p>Organisation and routines</p>

Q6	Is there anything you want to share about your role that you think I should have asked about?
	Stop recording. Thank you, thank you, thank you! Would you be open to a follow-up if needed and what means of communication would you prefer? If you know other CDOs in your network, would you introduce and recommend me? Thank you again!

10 Appendix – Plagiarism declaration form

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Declaration

I declare that this article is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.


A handwritten signature in black ink, consisting of several overlapping, fluid loops and strokes, positioned above a horizontal line.

Heinrich Pool

11 Appendix – Copyright declaration

Available on next page as separately merged pdf document.

22.1 COPYRIGHT DECLARATION FORM

Student details			
Surname:		Initials:	
Student number:			
Email:			
Phone:			
Qualification details			
Degree:	MBA	Year completed:	
Title of research:	GIBS		
Supervisor:			
Supervisor email:			
Access			
A.	My research is not confidential and may be made available in the GIBS Information Centre and on UPSpace.		
I give permission to display my email address on the UPSpace website			
Yes		No	
B.	My research is confidential and may NOT be made available in the GIBS Information Centre nor on UPSpace.		
Please indicate embargo period requested			
Two years		Please attach a letter of motivation to substantiate your request. Without a letter embargo will not be granted.	
Permanent		Permission from the Vice-Principal: Research and Postgraduate Studies at UP is required for permanent embargo. Please attach a copy permission letter. Without a letter permanent embargo will not be granted.	
Copyright declaration			
I hereby declare that I have not used unethical research practices nor gained material dishonesty in this electronic version of my research submitted. Where appropriate, written permission statement(s) were obtained from the owner(s) of third-party copyrighted matter included in my research, allowing distribution as specified below.			
I hereby assign, transfer and make over to the University of Pretoria my rights of copyright in the submitted work to the extent that it has not already been affected in terms of the contract I entered into at registration. I understand that all rights with regard to the intellectual property of my research, vest in the University who has the right to reproduce, distribute and/or publish the work in any manner it may deem fit.			
Signature:			Date:
Supervisor signature:	<i>Kerrin Myres</i>		Date: 30-11-2020

12 Appendix – Certification of data analysis support form

Available on next page as separately merged pdf document.

25. APPENDIX 6 CERTIFICATION OF ADDITIONAL SUPPORT

(Additional support retained or not - to be **completed by all students**)

Please note that failure to comply and report on this honestly will result in disciplinary action

I hereby certify that (please indicate which statement applies):

- ***I DID NOT RECEIVE*** any additional/outside assistance (i.e. statistical, transcriptional, and/or editorial services) on my research report:

.....

- ***I RECEIVED*** additional/outside assistance (i.e. statistical, transcriptional, and/or editorial services) on my research report

.....

If any additional services were retained– ***please indicate below which:***

- Statistician***
- Transcriber***
- Editor***
- Other (please specify:.....)***

Please provide the name(s) and contact details of all retained:

NAME:

EMAIL ADDRESS:

CONTACT NUMBER:

TYPE OF SERVICE:

NAME:

EMAIL ADDRESS:

CONTACT NUMBER:

TYPE OF SERVICE:

NAME:

EMAIL ADDRESS:

CONTACT NUMBER:

TYPE OF SERVICE:

I hereby declare that all *statistical write-ups and thematic interpretations of the results for my study* were completed by myself without outside assistance

NAME OF STUDENT:
.....

SIGNATURE: 

STUDENT NUMBER:
.....

STUDENT EMAIL ADDRESS:
.....

13 Appendix - Ethical clearance letter

Available on next page as separately merged pdf document.

GIBS ETHICAL CLEARANCE APPLICATION FORM 2020

RESEARCH PROJECT INFORMATION

NAME:	Heinrich Pool
STUDENT NUMBER:	15001623
PHONE NUMBER:	
E-MAIL ADDRESS:	15001623@mygibs.co.za
PROPOSED TITLE OF STUDY:	The role of the Chief Digital Officer in creating and maintaining the dynamic capabilities of the firm
RESEARCH SUPERVISOR:	Kerrin Myres
E-MAIL OF SUPERVISOR:	myresk@gibs.co.za

The purpose of this Research Ethics process is to ensure that all research conducted under the auspices of GIBS is done so in an ethical manner, in accordance with the University's policy and in such a way that **the rights of all stakeholders** associated with the research are protected.

In order for the GIBS Research Ethics Committee to assess your application, you are required to submit a **description of your Research Methodology** that must contain sufficient detail to ensure that the required steps have been taken to achieve this purpose, in the research design, data collection, analysis and storage of data used in the conduct of this research.

Please indicate the nature of the output your research is aimed at producing (mark one box only):

- PGDip Applied Business Project
- MBA/MPhil Research Report
- MBA Project Publish Article
- MBA Teaching Case Study
- MBA Entrepreneurship Stream Portfolio
- MBA Consulting Stream Portfolio
- GIBS Faculty/Research Associate/Staff member or others undertaking research under the GIBS affiliation

GIBS Ethics Policy distinguishes between FOUR main types of data and THREE main types of methodology. Please complete the table for ALL the data types that you plan to use. Note that all applications must be accompanied by a description of the methodology to be used in the study. Initial all sections that apply to your research

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Section of form and type of data or methodology	Attachments – including methodology chapter (please mark that they are included)
A Pre-existing personal records of human subjects, e.g. performance reviews	<input type="checkbox"/> Methodology section of proposal <input type="checkbox"/> Description of the nature of the records to be used <input type="checkbox"/> Permission letter from appropriately authorised person in the organisation to use the data
B New data solicited from human subjects, e.g. through interviews or surveys	<input checked="" type="checkbox"/> Methodology section of proposal <input checked="" type="checkbox"/> informed consent statement (separate for qualitative data collection; as part of survey questionnaire for quantitative data collection) <input checked="" type="checkbox"/> Interview guide / survey questionnaire / pre-existing proprietary test instrument / description of intervention <input checked="" type="checkbox"/> IF pre-existing proprietary test instrument, letter of permission from the owner/copyright holder (e.g. the MBTI)
C Public non-human data, e.g. World Bank or other databases (no letter needed)	<input type="checkbox"/> Methodology section of proposal <input type="checkbox"/> Explanation of the nature of the data, how you will source it and how you will use it
D Private Organisation-specific non-human data, e.g. financial statements, marketing or safety records	<input type="checkbox"/> Methodology section of proposal <input type="checkbox"/> Explanation of the nature of the data, how you will source it and how you will use it <input type="checkbox"/> Permission letter from the owner/organisation to use the data
E Indicate which methodology you will be using. Choose one only	<input checked="" type="checkbox"/> Qualitative <input type="checkbox"/> Quantitative <input type="checkbox"/> Mixed methods

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SECTION A. PRE-EXISTING PERSONAL RECORDS OF HUMAN SUBJECTS

1. Specify the nature of records and how they will be used

2. Confirm that permission has been obtained from an appropriately authorised person to study and report on these records.

Remember to attach permission letter(s).

I confirm

3. Provide the name and job title of the person in the organisation who has authorised the use of the records.

Name:

Job Title:

4. In the event that individual data is to be reported, how will anonymity be assured?

Mark all that apply – ensure this is included in your methodology chapter.

- No names will be requested
- No names will be reported
- Data will be stored without identifiers
- Only aggregated information will be provided
- Other. Please specify

SECTION B. NEW DATA OBTAINED FROM HUMAN SUBJECTS

5. Does the nature of your research require you to collect data from respondents who constitute a 'vulnerable population' (defined as those who are particularly susceptible to coercion or undue influence or who have difficulty giving free and informed consent to being the subjects of research)

No

Yes.

IF yes, explain the nature of the population and what measures will be put in place done to reduce or minimise this vulnerability. Ensure this is included in your methodology chapter.

6. Please confirm that no incentive is to be offered to respondents to participate in the study.

I confirm

7. Mark the applicable box(es) to identify the proposed procedure(s) to be carried out to obtain data.

Interview guide Attach if applicable

Survey questionnaire Attach if applicable

Pre-existing proprietary test instrument, e.g. MBTI Attach if applicable

IF a pre-existing proprietary test instrument is used, confirm that permission has been obtained to use it.

I confirm

Remember to attach permission letter(s) to use proprietary test instrument/s from an appropriately authorised person.

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- Intervention, e.g. training or experiment Describe in full in methodology chapter

8. Confirm that the data gathering is accompanied by a consent statement.

- I confirm

9. Where is the consent statement found?

- As part of the survey questionnaire, if quantitative data collection, in the introduction section of the questionnaire.
- As a separate document, if qualitative data collection, remember to attach.

10. Is there a risk that the respondents may not fully understand the nature of the study, or instructions or questions, or their rights as a result of language barriers between themselves and the researcher?

- No, there is not a risk
- Yes, there is a risk.
IF yes, how will the subjects' full comprehension of the content of the research, including giving consent, be ensured? Please specify, and include in methodology chapter

11. Do any respondents risk possible harm or disadvantage (e.g. financial, legal, reputational or social) by participating in the research?

- No
- Yes.
IF yes, explain what types of risk and what is done to minimise and mitigate those risks and include in methodology chapter.

12. Are there any aspects of the research about which subjects are not to be informed?

- No
- Yes.
IF yes, explain why, and how subjects will be debriefed, and include in methodology chapter.

13. Will the audio or video recorded data be transcribed and/or translated by an independent transcriber and/or translator?

- No
- Yes.
If yes, confirm that the transcriber and/or translator will be required to sign a non-disclosure agreement to protect the respondent's confidentiality, and include in methodology chapter
- I confirm. Remember to attach a pro-forma non-disclosure agreement

14. How will **confidentiality** (when the identity of the respondent is known to the researcher e.g. when data collection is via interviews) and/or **anonymity** (when the identity of the interviewer is not known to the researcher e.g. when data collection is via surveys) of the respondents and their data be assured? Include in methodology chapter

- No names will be requested, relevant when the identity of the respondent is not known to the researcher
- No names of individuals or organisations will be reported, relevant when the identity of the respondent is known to the researcher

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- Only aggregated information will be reported
- Data will be stored without identifiers
- Other. Please specify

15. Is the topic of your research and the nature of the interview or survey questions about one or more particular organisations or to be conducted within one or more particular organisations?

- No
- Yes. If yes, confirm that appropriately authorised person/s have provided written permission for you to conduct this research
- I confirm. Remember to attach signed permission letter/s

SECTION C. PUBLIC NON-HUMAN DATA

16. Specify the nature of records to be used: Explain how they will be selected, where the data will be sourced and how the data will be used, and include in methodology chapter:

17. Confirm that this pre-existing non-human data is in the public domain, is legally accessible and is free of any copyright.

- I confirm

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SECTION D. PRIVATE ORGANISATION-SPECIFIC NON-HUMAN DATA

18. Specify the nature of records (e.g. financial reports, marketing reports or safety records) and how they will be used.

19. Confirm that permission has been obtained to study and report on these records.

I confirm. Remember to attach permission letter(s).

20. Provide the name and job title of the person in the organisation who has authorised the use of the records.

Name:

Job
Title:

21. Do companies risk possible harm or disadvantage (e.g. financial, legal, reputational or social) by participating in the research?

No

Yes. Explain what types of risk and what is done to minimise and mitigate those risks. Include explanation in methodology chapter

22. How will **confidentiality** (when the identity of the respondent is known to the researcher e.g. when data collection is via interviews) and/or **anonymity** (when the identity of the interviewer is not known to the researcher e.g. when data collection is via surveys) of the respondents and their data be assured? Include in methodology chapter

No names will be requested, relevant when the identity of the respondent is not known to the researcher

No names of individuals or organisations will be reported, relevant when the identity of the respondent is known to the researcher

• Only aggregated information will be reported

• Data will be stored without identifiers

Other. Please specify

GIBS ETHICAL CLEARANCE APPLICATION FORM 2020

ALL APPLICANTS MUST COMPLETE SECTIONS E AND F

E. CONFIDENTIALITY OF RESEARCH REPORT SUBMITTED FOR EXAMINATION OR PUBLICATION

23. Please select the relevant option relating to the confidentiality of the research report you will submit for examination:

- Free access, i.e. report not embargoed
- No access for a period of two years after research report is submitted for examination
Note that in exceptional circumstances, GIBS, being the copyright holder of the published research, may consent to an embargo of the report submitted for examination for a period of no more than two years. If you wish to apply for such an embargo, please provide reasons for this in a separate attachment.
- No access under any circumstance for an undetermined period.
A letter of permission from the Vice- principal: Research and Postgraduate Studies at the University of Pretoria must be obtained prior to making this application – and attached to this application for ethical clearance.

F. DATA STORAGE AND DISSEMINATION OF RESEARCH REPORT SUBMITTED FOR EXAMINATION

24. Please confirm that you will use appropriate methods to ensure your data is safely stored in an accessible format for a minimum period of 10 years

- I confirm

25. Confirm that the details of your data storage method are set out in your attached methodology chapter

- I confirm

26. It is a goal of GIBS to make research available as broadly as possible. Mark the boxes below for the medium/media in which you do NOT wish results to be made available.

Academic dissemination

- Research report
- Scientific article
- Conference paper
- Book

Popular dissemination

- TV
- Radio
- Lay article
- Podcast
- Book

Provide reasons for any limitation on publication marked above

27. Confirm that the consent obtained is aligned with the extent of dissemination. For example, consent if you are planning to use the research to launch a consulting career will be more comprehensive than in the case of research that is intended only for a scientific audience.

- I confirm

28. IF you wish to describe any other information which may be of value to the committee in reviewing your application

- No
- Yes. Provide details in a separate sheet attached to this application

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G. APPROVALS FOR/OF THIS APPLICATION

When the applicant is a student of GIBS, the applicant must please ensure that the supervisor and co-supervisor (where relevant) has signed the form before submission

STUDENT RESEARCHER/APPLICANT:

29. I affirm that all relevant information has been provided in this form and its attachments and that all statements made are correct.

Student Researcher's Name in capital letters: HEINRICH POOL

Date: 01 Aug 2020

Supervisor Name in capital letters: DR KERRIN MYRES

Date: 01 Aug 2020

Co-supervisor Name in capital letters:

Date: 01 Aug 2020

Note: GIBS shall do everything in its power to protect the personal information supplied herein, in accordance to its company privacy policies as well the Protection of Personal Information Act, 2013. Access to all of the above provided personal information is restricted, only employees who need the information to perform a specific job are granted access to this information.

FOR DOCTORAL AND FACULTY/RESEARCH ASSOCIATE/STAFF MEMBER RESEARCH ONLY

Approved

REC comments:

Date: 27 Aug 2020