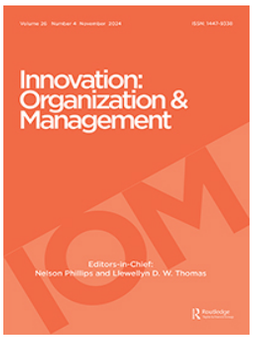

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Waking up to digital innovation: how organisational secrecy hampers top management focus on strategic renewal

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ABSTRACT

Small and medium-sized firms are increasingly adopting digital technologies to transform themselves. Yet, the ability of top-management teams to embark on strategic transformations depends on entrepreneurial ideas and initiatives that arise across the firm. We conducted a qualitative pre-study of manufacturing companies to understand their challenges in engaging in and implementing digital transformation. The study drew attention to the prevalence of internal secrecy that inhibits knowledge sharing across units and, therefore, complicates the identification and elaboration of customer-centric innovations based on digital data. Building on our initial findings and research, we then developed and tested hypotheses that relate organisational secrecy, competitive pressures, and the range of digital technologies in use to top management's shift in focus towards digital innovation. We find, in particular, that organisational secrecy impeds a shift in top management attention towards those forms of digital innovation that require complex cross-unit coordination. We also found that perceived external pressures from competition were associated with an increase in top management's focus on digital innovation. Our study contributes to the literature on digital transformation and strategy processes more generally by elaborating on how organisational secrecy can hamper strategic renewal. The findings suggest that a culture of openness and transparency can facilitate strategic renewal in established companies.

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New technological developments provide companies with attractive opportunities for 'digital transformation' of their existing businesses (Herbert, 2017; Kane et al., 2015; Rogers, 2016; Siebel, 2019). Yet, such transformation requires companies to engage in digital innovation that leads to new capabilities (Warner & Wäger, 2019), business models (Zott & Amit, 2017), organisational structures (Burton et al., 2019), and entrepreneurial initiatives (Nambisan, 2017). While large companies can invest in experimentation and even acquire startups to absorb digital innovations, the digital transformation process seems particularly daunting for small- and medium-sized enterprises (SMEs), which cannot typically afford to set up separate units to explore new technologies and business opportunities (Audia & Greve, 2006; Bingham et al., 2019).

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Thus far, little empirical research exists on factors that explain why some established SMEs develop and exploit digital innovation while others fail to do so (Bharadwaj et al., 2013; Osiyevskyy & Dewald, 2015).

In this multi-method article, we explore why top managers in SMEs redirect their attention to digital innovation. Based on inductive insights from our qualitative study, we focus specifically on the role of organisational secrecy in hampering the knowledge flows among front-line employees and middle managers that facilitate bottom-up innovation. Despite the prominence of secrecy in organisations, there has been surprisingly little empirical research on the topic (Costas & Grey, 2016; Pearce & Klein, 2017; Toegel et al., 2022). While management scholars have noted the value of secrecy for protecting knowledge (for a review, see Bos et al., 2015), its negative effects on strategic renewal have been overlooked.

Our qualitative pre-study of digital transformation processes in the manufacturing industry revealed organisational secrecy as a central impediment to identifying and pursuing digital innovation (Costas & Grey, 2014, 2016) and helped us develop a survey (Greene et al., 1989). Our findings drew attention to both *horizontal secrecy*, which confounded effective knowledge sharing and collaboration across distinct organisational units, and *vertical secrecy*, the inability of middle managers and front-line employees to access information and insights concerning their existing business and customer relationships, including, for example, the profit margins of specific products and customer segments. Our pre-study also drew attention to the role of external pressures from competition and the breadth of existing digital capabilities as precursors of digital innovation.

To assess the emergent findings of our qualitative study, we drew on research on organisational secrecy and strategy processes, including the attention-based view, to formulate a set of hypotheses. Building on our literature review and interviews, we distinguish between relatively incremental digital innovations, relating to the optimisation of operations, and complex digital innovations that span multiple units or disciplines, relating either to the management of customer relationships or new digital offerings (Bughin et al., 2017; Kane et al., 2015; Porter & Heppelmann, 2014; Rogers, 2016). We tested our hypotheses using a survey of Nordic manufacturing SMEs, focusing on top management's self-reported prospective intention to engage in digital innovation in three distinct domains of digital innovation while controlling for past engagement.

Our analyses support the qualitative observations that organisational secrecy inhibits manufacturing companies' efforts to explore more complex digital opportunities relating to digital customer interfaces and new services when companies are less experienced with digital innovation. Secrecy derives from formal and informal social processes that inhibit managers and front-line employees from accessing information and knowledge across internal boundaries, such as trust and social norms (Costas & Grey, 2014, 2016). The lack of open information sharing confounds an organisation's ability to identify and explore new digital opportunities that cut across established units. We further found external pressures to increase the focus on digital innovations. Controlling for past strategic focus, we failed to find significant effects for organisations' breadth of digital capabilities. To corroborate the perceptual indicators, we conducted further qualitative analysis of investments in eight manufacturing firms (see Appendix B).

Our study contributes to the emerging research on digital innovation and transformation processes (Autio et al., 2018; Nambisan, 2017, 2019) by highlighting the need for transparency in pursuing complex digital opportunities, particularly in SMEs that depend on bottom-up initiatives (Bingham et al., 2019; Floyd & Wooldridge, 1999) to create new capabilities. More broadly, we integrate the emerging research on organisational secrecy into research on the strategy process, highlighting its role as a central impediment to strategic renewal by hampering the identification and development of entrepreneurial initiatives that cut across organisational units.

Theoretical background: the role of secrecy in strategic renewal

Because digital transformation represents a systemic change in organisations' capabilities and processes (Boland et al., 2007), it requires deliberative involvement and decisions from top management. However, top-management teams tend to be relatively inert in their priorities (Shepherd et al., 2017) and focus their attention on familiar issues and initiatives (Ocasio et al., 2018). Research has suggested that strategic renewal often requires bottom-up initiatives and middle management support that shapes the top management's agenda (Floyd & Lane, 2000; Vuori & Huy, 2016; Wooldridge & Floyd, 1990). However, smaller companies may lack the resources needed to foster bottom-up exploration (Ott et al., 2017) that would convince top managers to embrace the new opportunities for digital innovation.

The strategy processes research has noted the importance of bottom-up ideas in shaping strategic decisions when top-management teams endorse suggested strategic actions and reallocate resources (Eggers & Kaplan, 2009; Floyd & Lane, 2000; Floyd & Wooldridge, 1999; Ocasio, 2011) as they assess new opportunities and threats (Bouquet & Birkinshaw, 2008; Kaplan, 2008; Maula et al., 2013; Vuori & Huy, 2016). We integrate insights from the recent research on organisational secrecy into the strategy process perspective to lay the ground for our qualitative pre-study.

Digital transformation as strategic renewal

Digital technologies are creating opportunities to develop entirely new competitive strategies (e.g., Bharadwaj et al., 2013), motivating strategic renewal processes that involve the development of new capabilities that radically improve the firm's long-term competitiveness (e.g., Hess et al., 2016; Yoo et al., 2006). Such changes are reshaping even the traditionally conservative manufacturing industries (Industrie 4.0 report). Drawing on Nambisan et al. (2019), we define digital transformation as the systemic process through which companies reshape their strategy and capabilities with the help of digital technologies (Demir, 2015; Jarzabkowski & Kaplan, 2015). Digital infrastructures have motivated a change towards more entrepreneurial (Burton et al., 2019) and agile organisational structures and processes (Herbert, 2017; Hess et al., 2016; Yoo et al., 2012) and have increased both cross-functional collaboration (Barrett et al., 2012) and transparency (Granados & Gupta, 2013; Turco, 2016). Across industries, digital transformation has been associated with new business models, reshaped ecosystems, and has given birth to transaction and innovation platforms (Autio et al., 2018; Cusumano et al., 2019; Nambisan et al., 2018; Srinivasan & Venkatraman, 2018). The literature has noted digital

transformation to involve various changes in strategy, organising, and even managers' norms (Schildt, 2020).

Strategic renewal requires companies to create new organisational capabilities, typically through strategic initiatives (Floyd & Wooldridge, 1999). The emergence of such initiatives depends on the involvement of diverse actors throughout the organisation. The literature has noted that it is front-line employees and lower-level managers that tend to conceive entrepreneurial initiatives, as they are more knowledgeable about customer needs and technological opportunities (Demir & Knights, 2021; Kannan-Narasimhan & Lawrence, 2018). The practice and process turn in strategic management has further emphasised the role of employees and middle managers in driving the strategic agenda in the direction set by the top-management team (Bingham et al., 2019; Burgelman et al., 2018; Ocasio et al., 2018; Whittington, 2006). Middle managers can contribute to top management's sensemaking process by surfacing new opportunities (Rouleau, 2005) and capturing top management's attention (Rouleau & Balogun, 2011). However, middle managers' impact on firm-level renewal depends on top management's support and recognition (Burgelman, 1991; Dougherty & Hardy, 1996; Floyd & Lane, 2000; Mintzberg & Waters, 1985). The ability of a firm to renew its capabilities and remain competitive may depend on the exploration of new opportunities that often involve a combination of top-down and bottom-up attention (Shepherd et al., 2017).

The attention-based view (ABV) has provided further insight into the strategy practice and process turn by elaborating how organisational structures, work roles, and central processes both 'distribute' various actors' attention to diverse issues and 'channel' and 'integrate' attention across hierarchical levels and unit boundaries (Joseph & Ocasio, 2012; Ocasio, 1997). Managers often overlook entrepreneurial opportunities because their attention is focused on issues that have greater legitimacy and perceived value and are embedded within their task domains (Ocasio, 1997) and practice repertoire (Nicolini & Korica, 2021). While many actors contribute to the focus of an organisation, top management tends to be the crossing point 'at which information converges and is interpreted for organisational-level action' (Nadkarni & Barr, 2008, p. 1396), such as innovation (Dahlander et al., 2016), production and distribution (Siggelkow, 2001), and resource alteration (Danneels, 2011).

Digital transformation represents a specific case of strategic renewal, where companies engage in digital innovation to develop diverse new capabilities. Research has highlighted three central domains of digital innovation relevant to the manufacturing industry with different levels of complexity. First, digital technologies such as sensors that can be used for real-time monitoring of several parameters enable companies to collect enormous amounts of data that can be used to optimise operations and form bases for real-time decision-making (McAfee & Brynjolfsson, 2012). These uses are relatively incremental because optimisation tends to be limited to specific internal processes and outcomes. Second, digital technologies allow constant interactions between entrepreneurial firms and their customers, creating opportunities for new kinds of relationships and value creation (Schwab & Zhang, 2019). These digital customer relationships allow companies to proactively address customer problems and needs (March & Scudder, 2019; Wan et al., 2017) and develop new business models (Amit & Han, 2017; Pagani, 2013; Zott & Amit, 2017). Third, digital technologies can help develop entirely new capabilities to generate valuable products and services. Researchers have noted that digital innovation often involves 'servitization' (Frank et al., 2019), where companies complement and replace

existing physical products with new services and solutions (Allmendinger & Lombreglia, 2005; Davis & Botkin, 1994; Porter & Heppelmann, 2014; Rijsdijk & Hultink, 2009). The last two domains of digital innovation are more complex, because they typically require coordination across multiple units and knowledge domains.

Organizational secrecy

We conceive organisational secrecy as a social phenomenon constituted by the 'formal and informal social process of the intentional concealment of information' within the organisation (Costas & Grey, 2014, p. 1423). *Formal* secrecy is guided by rules and regulations that limit information sharing, commonly through positions and roles. Formal secrecy tends to be linked to product knowledge, trade secrecy, client confidentiality, budgets, and data protection (Costas & Grey, 2014, 2016). *Informal* secrecy operates through 'socially negotiated norms, beliefs, morals or conventions [that] regulate what is kept secret and how, who is to be entrusted with the secret and what the sanctions for secrecy breach are' (Costas & Grey, 2014, p. 1423). Informal secrecy occurs in cliques, networks, and groups between and within organisational units. Both formal and informal secrecy limit the ability of front-line employees and middle managers to understand and evaluate novel business opportunities, thus hampering the development of new initiatives.

Recent research has approached the phenomenon as a social process that has overall positive and negative effects on individuals and the organisation (Costas & Grey, 2016; Toegel et al., 2022). Organizational secrecy has largely been studied as a negative force. At worst, it reduces trust and commitment and instigates unethical behaviour, conflict, harmful gossip, and resistance movements (Anand & Rosen, 2008; Costas & Grey, 2016). Importantly, secrecy creates social order as it can construct, maintain, and destroy groups, cliques, and managerial circles by defining group membership, demarking who is in the entrusted circle and who is not (Costas & Grey, 2016), leading at times to conflicts and unnecessary politics (Anand & Rosen, 2008). Concerning organisational policy, secrecy has been shown to create employee distrust in the organisation (Pearce & Klein, 2017).

Examining secrecy in the context of strategy processes, Toegel et al. (2022) noted three specific effects secrecy had on developing and promoting initiatives. Secrecy structures cognition by grabbing one's attention, helps actors manage emotions by creating a sense of psychological safety to develop initiatives more freely, and facilitates exchange relations by creating a sense of reciprocity: inner-circle actors express more support for new ideas.

It is worth noting that organisational secrecy has clear connections with the older research streams on knowledge hiding and knowledge transfer (Hamel, 1991; Leonard-Barton, 1995; Szulanski, 1996), even though the literatures have remained disconnected. Knowledge hiding refers to an 'intentional attempt by an individual to withhold or conceal knowledge that has been requested by another person' (Connelly et al., 2012, p. 65). This dyadic process can involve playing dumb, evasive hiding, and rationalised hiding (Connelly et al., 2012). As opposed to knowledge hiding, the experience of organisational secrecy is not limited to specific situations or behaviours but represents a broader social process of continuous and systematic withholding of information

embedded in structures and social norms (Costas & Grey, 2016). The knowledge-sharing literature similarly focuses on dyadic linkages between those who hold specific knowledge and those who can benefit from it. While knowledge-sharing research typically examines hard-to-transfer learning requiring absorptive capacity (Dyer & Hatch, 2006), organisational secrecy affects a wide range of easy-to-transfer observations, such as unmet customer needs. As such, barriers to knowledge transfer tend to matter for realising innovative ideas and strategic initiatives, while secrecy likely hinders initial idea generation.

Qualitative pre-study

To better understand the manufacturing industry and the specific challenges related to the adoption and use of new digital technologies, including their efforts in 'digital innovation', we conducted a qualitative study of SMEs in the manufacturing sector in Finland and Sweden, seeking to understand their digital transformation efforts.

Data and methods

We conducted semi-structured interviews with top-management team members, department heads, and strategy directors, discussing their companies' goals, plans, and processes related to using software and digital data. Our data sources consist of 50 interviews (28 in Finland, 22 in Sweden) in 21 industrial companies in 2015. These interviews were summarised in memos, highlighting the informants' perceptions of key catalysts and inhibitors for digital transformation.

We adopted an inductive open coding approach to analyze our data. As we read through the interviews, we highlighted key passages concerning managers' motives and actions related to digital transformation. We continuously iterated between the relevant literature on strategy processes and digital strategy, the interview data, and the emerging coding scheme (Corbin & Strauss, 2014; Gioia, Corley, & Hamilton, 2013).

Key findings

Aligned with the literature, we found that the most common domain of digital innovation mentioned by the manufacturing companies involved the optimisation of processes. Typical examples included condition-based maintenance and minimisation of energy consumption. Other less prominent application areas included the development of ongoing long-term customer relationships, supported by digital channels and involving new revenue models, and developing new product features and services that utilised software, often to complement traditional equipment sales and maintenance services. One CEO claimed, 'those not adopting this will be losers because how you interact with your customer will be totally different in the coming years'. Although informants often mentioned the desire to create new data-based products and services, the exact details were generally either confidential or uncertain.

Our informants noted the distributed and emergent nature of digital innovation initiatives; one Chief Information Officer (CIO) noted, 'we've been trying consciously to keep it to "freedom to experiment". The corporation's role would rather be to support

and encourage the initiatives'. In line with the literature, the digital transformation efforts benefited from support from top management and other units. A program manager explained, 'although we have a good backup from the CEO level, there are other organisational levels [that are pushing back.]'.

A central theme emerging from our interviews was the lack of access to information and knowledge inside the companies, explaining the difficulties of creating and testing new digital solutions. While a *culture of secrecy* prevailed in the companies, the new demands of digital transformation made it problematic. Managers confessed that their companies lacked transparency and information sharing enabling cross-functional collaboration. One vice president explained, '[The projects don't work] when everyone has to spend half of the time thinking of the motives of these other people. Of course, we will have secrets in the future, but we [want to develop] transparency as a central driver of collaboration'.

While secrecy involved practices and regulations, such as access to databases, many informants also described social norms, practices, and habits that constituted organisational secrecy (Costas & Grey, 2016). For example, one manager noted that he would be entitled to ask other department heads about their profit margins but confessed that it would 'feel weird' and 'nosy'. Our informants connected secrecy specifically to digital transformation, noting that most innovations were conceived within 'siloes' in the pre-digital era. In contrast, the ability of companies to become more customer-oriented, which was perceived as a significant benefit of digital innovation, required greater coordination throughout the company.

Beyond secrecy, our interviews revealed several other factors often recognised in the innovation literature. Reflecting on the facilitators and barriers to developing digital innovations, our informants emphasised factors widely reported in the literature, such as experimentation with users (e.g., Parmentier & Mangematin, 2014) and collaboration across functional specialisations (e.g., Dery et al., 2017). Due to the relatively conservative business purchasing processes, new solutions were often driven by technology rather than customer demand in these largely business-to-business companies. One CEO noted, '[t]he customers are actually in a very passive role right now. They have allowed us to collect and utilise data. They are waiting to see what is to come'. Our informants often referred to their foreign competitors to justify perceptions of industry-level digital transformation and the need to find new sources of differentiation. Hence, our informants tended to follow the developments of their competitors keenly.

Hypothesis development

We drew on the literature review and pre-study to develop hypotheses that outline the organisational determinants for the management team's shifting strategic focus, measured as their intention to innovate in distinct domains of digital innovation, controlling for their past focus on these areas. In other words, we theorise the organisational factors that explain top managers' shift in focus to opportunities related to digital innovations.

Our hypotheses are premised on the assumption that top-management beliefs and intentions remain largely constant over time (Cyert & March, 1963), suggesting that efforts to explain top managers' strategic focus need to take any prior focus into account (Gavetti et al., 2012). Managerial work is characterised by a high degree of 'busyness' and

high demands from multiple individuals and sources (Simon, 1947), requiring managers to allocate attention to a wide range of issues that are important to the task at hand (Ocasio, 1997; Shepherd et al., 2017). The top managers focus on issues and demands in their immediate task domain, which have become part of their cognitive and behavioural schema (Cyert & March, 1963). Consequently, managers who have previously focused on a specific domain of digital innovation are likely to do so irrespective of organisational factors. Our hypotheses thus examine the antecedents of an increase in management focus on incremental and complex digital innovations.

Organizational secrecy and digital innovation

Research on innovation has long emphasised the role of knowledge sharing in developing new ideas (Tsai, 2001; Zhou & Li, 2012). Grant (1996) argued that strategic renewal depends partly on the company's ability to recombine the knowledge it generates and holds. Because all companies have specialised teams with unique knowledge, the social networks and knowledge sharing norms and practices within the company influence the innovative output of the firm (Tsai, 2001). During our pre-study, our informants flagged information withholding as a problem for pursuing digital opportunities in manufacturing companies, which had long relied on relatively autonomous units with strong financial incentives. Such compartmentalisation of the organisational structure (Burgelman, 1983) is a significant contributor to organisational secrecy (Costas & Grey, 2016) and knowledge hiding (Connelly et al., 2012). While knowledge sharing may not be vital for technological innovations that rely on deep expertise (Zhou & Li, 2012), many aspects of this technological shift and related business model innovations in digital transformation may involve architectural change and coordination across multiple business units (Fjeldstad & Snow, 2018). Prior research has often treated knowledge hiding as an individual-level behaviour linked to reduced creativity in others and the focal actors themselves (Černe et al., 2014). However, at the organisational level, knowledge hiding is likely to stem from established processes of secrecy (Costas & Grey, 2014) that normalise the lack of transparency across unit boundaries and hierarchical levels (Schnackenberg & Tomlinson, 2016).

Secrecy is likely to be particularly problematic for conceiving and developing strategic changes that require access to diverse knowledge and coordination across unit boundaries as it hampers vital collaboration (Costas & Grey, 2016). Secrecy does not entirely inhibit knowledge flows, as secrets can be widely shared; yet, such information flows may be oriented to achieve individual rather than organisation-wide targets (Puyou, 2018). Research has found knowledge sharing particularly important when innovations take advantage of diverse knowledge areas (Zhou & Li, 2012). In particular, the ability of firms to leverage digital technologies to create new products and services is likely to require information sharing and coordination across unit boundaries. Without such knowledge sharing, ideas that could redirect top-management attention to digital innovation opportunities are likely to go unnoticed. In sum, a secretive culture is likely to inhibit the creation of entrepreneurial initiatives related to digital innovations (Nambisan, 2017).

The ABV view suggests that managerial attention to strategic issues is likely to be sticky as it becomes embedded in organisational structures and mental models (Ocasio et al., 2018; Ocasio, 1997). Consequently, we predict the adverse effects of secrecy to be

particularly high in organisations where managers exhibit a low prior focus on digital innovation. Moreover, the effects of secrecy are likely to be pronounced in domains of digital innovation that involve more complex integration of organisational capabilities and thus greater cross-unit coordination. Leveraging data and smart algorithms to optimise operations – such as maintenance, production volumes, or energy consumption – tends to be confined to specific units and thus involves limited coordination efforts. In contrast, digital innovations related to customer relationships and offerings tend to involve a more complex integration of capabilities to serve external stakeholders, thereby requiring greater coordination.

Thus, we hypothesise:

Hypothesis 1a: The greater the perceived level of secrecy in a firm, the lower the managers' intent to innovate in each domain of digital innovation. This negative effect should be pronounced when prior focus is low.

Hypothesis 1b: The effects of secrecy are strongest for complex digital innovations that require greater cross-unit coordination (customer relations and offerings) and weaker for incremental innovation (operational efficiency).

External pressures and digital innovation

While our primary hypothesis focused on internal determinants of strategic change, several studies have noted that external stimuli can represent a strong trigger for strategic change and adaptation (Barnett, 2008; Joseph & Ocasio, 2012; Vuori & Huy, 2016). In particular, competition can create a sense of urgency and legitimise change. Firms tend to follow their proximate competitors and build collectively accepted industry models and macro-cultural belief systems (Porac et al., 1995). Kaplan (2008) found systematic relationships between investments in emerging technologies in the optical disc industry and CEOs' attention to external threats. Top managers are likely to shift their strategic focus when they acknowledge disruptive new technologies (Kaplan, 2008) or their potential implications for the affected industry (Eggers & Kaplan, 2009). Benner and Tripsas (2012) similarly found that firms tend to notice and imitate the behaviours of leading firms in their industry. These earlier findings lead us to expect similar patterns for SMEs in the context of digital transformation. That is, the greater the external pressure from competitors, the more likely top managers will direct their focus onto digital innovation.

We expect external pressures to trigger attentional engagement from managers (Ocasio, 2011), but the responses are likely to become increasingly subdued as the company gains experience in the relevant domain of digital innovation. Thus, similar to Hypothesis 1a, we expect the effects to be greatest when there is limited prior attention, given the stickiness of past attention (Ocasio, 1997). Hence:

Hypothesis 2: The greater the perceived external pressure towards digital transformation, the greater the managers' intent to innovate in each domain of digital innovation, particularly when prior focus is low.

Digital breadth and digital innovation

Past research has long emphasised the importance of diverse knowledge and established capabilities as the basis for 'recombinant innovation' (Dahlander et al., 2016; Leiponen & Helfat, 2010). In SMEs with limited resources for exploration, the established digital capabilities are likely to provide an important basis for identifying and pursuing digital innovation. Although patent-based studies have shown how recombining pre-existing knowledge facilitates the formation of new inventions (Fleming, 2001; Fleming, 2001), it is unclear if these dynamics apply to digital innovations that are new only to the company in question and not to the world.

We expect digital breadth to create greater bottom-up engagement and issue selling towards top management (Ocasio, 2011), but similar to the hypotheses above, we expect those efforts to be the greatest when top management has paid limited prior attention to digital innovations. Once top managers have devoted attention to a specific domain of digital innovation, they are likely to develop organisational structures that maintain continued attention even in the absence of bottom-up impetus for new ideas (Ocasio, 1997).

We thus hypothesise that employees in companies with a greater breadth of digital capabilities will identify more compelling opportunities for digital innovation that ultimately increase top management's focus on digital innovations:

> **Hypothesis 3:** The greater the digital breadth of capabilities, the greater the managers' intent to innovate is in each domain of digital innovation, particularly when prior focus is low.

Quantitative study

The objective of this study was to understand the factors that predict digital transformation, conceived as an increase in top management's strategic focus on distinct domains of digital innovation. A suitable way of measuring such unobserved constructs is direct inquiry based on self-report measures (Osiyevskyy & Dewald, 2015). We chose to study this in the context of the manufacturing industry. Although the companies vary in their internal processes and products, our qualitative pre-study in the manufacturing industry suggested that the key issues are broadly the same across companies. We ensured that the dependent and independent variables were phrased with a level of abstraction that made them relevant to all manufacturing companies.

Data collection and descriptive statistics

We sent a survey in 2016 to top-management team members of small and medium-sized manufacturing firms in Finland and Sweden. The firms in our sample represent a wide range of the manufacturing sector, from road construction equipment and agricultural production systems to precision components and wood-processing equipment. We followed up on our initial survey email with two reminders, each a week apart. We also collected additional company data, including their accounting profits, revenues, and employee count. This data is available in public repositories where companies must report their financial information annually in both countries.

We received 407 electronic survey responses (203 from Finland and 204 from Sweden), representing a 14.4% response rate. Of the Finnish respondents, 86.2% were CEOs, and the rest were other top-management team members and company board chairs. Of the Swedish respondents, 73% were chief technology officers (CTO), and 27% were chief information officers (CIO). We removed all the survey responses with a substantive number of missing values (50% or over) and two outliers.[1] The final sample comprised 218 responses, of which 121 were from Finland and 97 were from Sweden.[2] Overall, 48.2% of the sample were CEOs. Firms in both countries were similar in size, on average 253.5 employees in 2014 and €4 million average profit in 2015.

Measurement

The survey was developed based on theory, and we used scales from previous studies whenever possible, adapting them to the manufacturing context. The dependent constructs that capture strategic focus on digital innovations were based on Osiyevskyy and Dewald's (2015) *Intention to innovate* scale. Based on pretesting in both countries and our literature review, we adapted the items from the original real estate context to fit the manufacturing industry. The respondents self-reported the items on 5-point Likert scales ranging from 1 = *extremely unlikely* to 5 = *extremely likely*. Respondents identified which actions they *are considering in the next two years* in relation to digital innovation. The survey questions asked respondents to consider three distinct domains of digital innovation: optimisation of operations, customer relationships, and offerings. Optimising operations, the least complex domain of digital innovation, was captured with two items: 'reducing costs from internal processes and operations' and 'introducing new data analytics solutions to optimise business processes'. The customer-facing dimension captured intentions to develop new customer interaction processes. The scale had three items, including 'enabling customers to connect products with their information systems'. The focus on the offerings dimension had four items capturing value-adding intentions to introduce new services and offerings, including 'expanding to new product categories'. Further details are reported in Appendix A.

The model includes three independent variables: external pressures, digital breadth, and organisational secrecy, which are moderated by prior focus on each digital innovation domain. *Managers' prior strategic efforts in each domain of digital innovation* were assessed with the same scale as the dependent variable, but we changed the question wording to capture strategic actions that respondents '*have already made during the past two years*'. We adapted the stakeholder pressure scale from Darnall et al. (2010) to measure external pressure. Respondents identified the importance of various stakeholders for developing digital offerings and processes on a 5-point Likert scale ranging from 1 = *not at all important* to 5 = *extremely important*. External pressure was measured with two items capturing the perceived importance of existing competitors in the development of digital processes and offerings. Second, *digital breadth* was adapted from Dahlander's et al. (2016) scale on external search breadth. Respondents were asked to indicate whether their firm currently uses specific technologies from a list of nine different types of digital technologies and practices: 1) sensors in products, 2) wireless data transfer in products, 3) statistical analysis tools, 4) cloud-based data warehouse, 5) computer-aided manufacturing, 6) computer-

integrated manufacturing process, 7) big data technologies (e.g., Hadoop), 8) application programming interfaces (APIs), and 9) 3D printing. The digital breadth variable ranges from 0 to 9 based on the number of digital technologies and practices identified by the respondent.

Finally, because no pre-existing scales were found for *organisational secrecy*, we developed one specifically for this study. Drawing on our qualitative pre-study, pretests, and literature review (e.g., Costas & Grey, 2014, 2016; Hansen & Flyverbom, 2015), the scale measures secrecy as the perception of processes and structures that limit information flow, creating a culture of secrecy. Three experts evaluated the scale to increase construct validity. The organisational secrecy scale was a 5-point Likert scale ranging from 1 = *strongly disagree* to 5 = *strongly agree*. All multi-item scales and corresponding construct validity and reliability indices are available in Appendix A.

We included three control variables in the final models. First, we controlled for the *respondent's role* by using a binary variable labelled CEO; since CEOs have a broader perspective of the organisation than other top-management team members, they might differ systematically in their assessments of both the dependent and independent variables.[3] Second, we included the natural logarithm of employee count from 2014 to control for *firm size*. Third, we included the profit margin from 2015 to represent the firms' financial health and the availability of slack resources.

Validity and common method bias

Table 1 presents fit indices and construct correlations. The measurement items were verified using confirmatory factor analysis (CFA) with AMOS software. Due to our sample size, separate analyses were run for focus intentions and prior focus on the three domains of digital innovation.

The measurement models' fit indices are relatively good. Convergent validity refers to the common variance of the variables in a construct share, commonly assessed through average variance extracted (AVE) and construct reliability (CR). All the construct reliabilities are acceptable, exceeding the recommended level of 0.60 (Bagozzi & Yi, 1988). The AVEs are also satisfactory, exceeding 0.50 (Hair et al., 1998) in most cases; prior focus on customer relationships (AVE = 0.472), and future focus on customer relationships (AVE = 0.497) have AVEs just below 0.5. However, the values were relatively close to the recommended threshold level. Overall, the CFA models show a good fit in that $\chi 2$ adjusted by the degrees of freedom is well below the recommended level of 3.0 (Iacobucci, 2010) in all models. The squared construct correlations were compared with the AVEs (Fornell & Larcker, 1981) and were lower in all cases except one, thus confirming discriminant validity for the other constructs. Prior and intended focus on customer relationships had a high construct correlation (0.755 correlation significant at $p < 0.001$ level). To further assess discriminant validity, an $\chi 2$ difference test was performed for the two constructs, revealing that a constrained model achieved a significantly lower fit than the unconstrained model: 12.4 $\Delta\chi 2$ (1df) $p < 0.01$. Thus, the focal constructs are empirically distinct from one another, even though highly correlated.

There are two primary ways common method bias can be controlled in survey research: the study design and statistical tests (MacKenzie & Podsakoff, 2012). Before data collection, we conducted pretesting in both countries to assess item ambiguity and

Table 1. Fit indices and construct correlations.

Measurement Models	*p*-value	X^2	d.f.	RMSEA	SRMR	CFI	GFI	NFI	x^2/(d.f.)		
Model 1: Focus on domain	0.486	23.6	24	0.000	0.025	1.000	0.977	0.974	0.983		
Model 2: Prior focus on domain	0.816	17.7	24	0.000	0.023	1.000	0.982	0.982	0.738		
Correlations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1. Focus on optimising	-										
2. Focus on customer	0.407**	-									
3. Focus on offerings	0.509**	0.680**	-								
4. Size (number of employees) 2014[a]	0.271**	0.132	0.160*	-							
5. Profit margin 2015	−0.040	0.100	0.079	−0.150*	-						
6. Prior focus on optimising	0.679**	0.348**	0.421**	0.254**	−0.003	-					
7. Prior focus on customers	0.258**	0.755**	0.482**	0.136*	0.083	0.443**	-				
8. Prior focus on offerings	0.354**	0.543**	0.734**	0.137*	0.021	0.598**	0.638**	-			
9. Organizational secrecy	−0.167*	−0.196**	−0.301**	0.024	−0.111	0.189**	−0.218**	−0.313**	-		
10. External pressure	0.397**	0.384**	0.400**	0.139*	−0.053	0.333**	0.253**	0.292**	−0.053	-	
11. Digital Breadth	0.297**	0.454**	0.384**	0.321**	0.052	0.383**	0.523**	0.422**	−0.140*	0.277**	-
Mean	3.796	3.494	3.540	4.246	0.027	3.102	2.650	2.810	2.387	2.810	3.400
Standard deviation	0.856	0.942	0.951	1.370	0.119	0.961	0.934	1.037	0.923	1.045	2.016
Average Variance Extracted	0.519	0.497	0.625	-	-	0.568	0.472	0.659	0.718	0.659	-
Construct Reliability	0.682	0.746	0.867	-	-	0.724	0.725	0.884	0.835	0.852	-

Note. [a]= Logged value. N = 218. RMSEA = root mean square error of approximation; SRMR = Standardised root mean square residual; CFI = Comparative Fit Index; GFI = Goodness-of-Fit; NFI = Normed Fit Index. Figures below the diagonal indicate construct correlations. **Correlation significant at 0.01 level (2-tailed). *Correlation significant at 0.05 level (2-tailed).

complexity. The survey instrument was validated by four industry experts in both countries, who made sure the questions were clear and made sense for the respondents. The survey was distributed in Finnish and English in Finland and Swedish and English in Sweden. A professional translator conducted back-translation in both countries to ensure the meaning was successfully maintained. Additionally, the survey included a cover letter, which stressed the importance of the respondents' personal opinions and the importance of the research. Further, to increase motivation, the respondents were offered a report comparing their responses to the mean responses in our sample. Steps were also taken in the research design to minimise conditions that might have caused method biases. For example, participation was voluntary, communication with respondents was respectful, and their anonymity was guaranteed. Finally, the post hoc Harman's statistical test reveals that the single-factor solution accounts for 31% of the set's variance. Thus, the test does not reveal a single factor simultaneously accounting for the constructs.

Finally, we sought to verify the validity of our survey-based dependent variable by examining the actual digital investments made by a subsample of companies, based on published data. We randomly selected two companies from four categories, sampling firms with a low/high intention to innovate (top 25% and bottom 25% of the distribution) in incremental/complex digital innovations. The synopses of illustrative company investments in each of these four categories are displayed in Appendix B. This qualitative post-hoc analysis suggests that top managers' reported intent to invest in digital innovations appears to be related to actual subsequent investments, albeit imperfectly.

Empirical analysis

Several OLS regression equations were estimated to test the hypotheses. Table 2 represents the results of hypothesis testing, with three distinct dependent variables to capture different domains of digital innovation. In our regression model, we tested for multicollinearity. We found that it did not threaten the results reported for the regression, as the highest VIF statistics range in all models was 1.623. We further assessed each significant interaction using simple slope analysis with Hayes PROCESS macro v3.4.

Results

Hypothesis 1a posited that the greater the perceived level of secrecy in a firm, the less managers intend to focus on each domain of digital innovation. This negative effect should be pronounced when prior focus is low. *Hypothesis 1b* posited that the effects of secrecy are strongest for complex digital innovations that require greater cross-unit coordination (customer relations and offerings) and weaker for incremental innovation (operational efficiency). Our results provide support for these hypotheses. As hypothesised, the effect of secrecy had a significant interaction effect with prior focus for the two more complex domains of digital innovation, customer relations ($b = 0.109$, $t(198) = 2.015$, $p = 0.045$), and offerings ($b = 0.104$, $t(198) = 2.101$, $p = 0.037$). The effects were non-significant for optimisation of business processes ($b = -0.002$, $t(198) = -0.043$, $p = 0.966$).

A simple slope analysis revealed that organisational secrecy had a significant and negative relationship with focus intentions on customer relationships (Model 6) at the low level of prior focus on customers ($b = -0.159$, $t(214) = -2.596$, $p = 0.010$). At

Table 2. Regression coefficients.

	Focus on optimising operations			Focus on customer relationships			Focus on offerings		
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
CEO or other	0.058	0.039	0.040	0.161*	0.107*	0.103	0.219**	0.101*	0.103*
	(0.121)	(0.090)	(0.090)	(0.135)	(0.087)	(0.085)	(0.134)	(0.093)	(0.091)
Size (number of employees) 2014[a]	0.275***	0.101*	0.094^{+}	0.113	0.008	0.004	0.118^{+}	0.024	0.022
	(0.045)	(0.035)	(0.036)	(0.050)	(0.034)	(0.033)	(0.050)	(0.036)	(0.035)
Profit margin 2015	0.023	−0.011	−0.010	0.137	0.047	0.037	0.124^{+}	0.075	0.059
	(0.521)	(0.384)	(0.384)	+(0.580)	(0.373)	(0.366)	(0.577)	(0.393)	(0.386)
Prior focus on domain[b]		0.584***	0.585***		0.678***	0.703***		0.590***	0.612***
		(0.052)	(0.053)		(0.055)	(0.055)		(0.052)	(0.051)
Organizational secrecy		−0.041	−0.038		−0.027	−0.014		−0.089	−0.061
		(0.051)	(0.051)		(0.050)	(0.049)		(0.054)	(0.055)
External pressure		0.207***	0.203***		0.169***	0.167***		0.190***	0.190***
		(0.046)	(0.046)		(0.044)	(0.043)		(0.046)	(0.045)
Digital breadth		−0.019	−0.020		0.036	0.032		0.051	0.041
		(0.025)	(0.056)		(0.026)	(0.026)		(0.026)	(0.026)
Prior focus on domain[b] x org. secrecy			−0.002			0.098*			0.108*
			(0.051)			(0.054)			(0.050)
Prior focus on domain[b] x External pressure			−0.108^{+}			−0.087+			−0.105*
			(0.058)			(0.061)			(0.044)
Prior focus on domain[b] x Digital breadth			−0.011			−0.001			0.044
			(0.024)			(0.022)			(0.022)
R^2 (Adjusted)	0.070	0.502	0.507	0.046	0.612	0.630	0.069	0.574	0.595
Max VIF	1.041	1.334	1.370	1.041	1.568	1.623	1.041	1.440	1.472

Note. N = 218. Entries are standardised regression coefficients. Standard errors are in parentheses. $^{+} = p < 0.10$; * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$. [a] = Logged value. [b] = dependent variables are matched with the corresponding domain of digital innovation in each model. VIF = Variance Inflator Factor.

the average level ($b = -0.029$, $t(214) = -0.634$, $p = 0.527$), and the high level of prior focus on customers ($b = 0.101$, $t(214) = 1.599$, $p = 0.111$), secrecy was non-significant. Similarly, the analyses revealed that secrecy had a significant relationship with focus intentions on offerings (Model 9) only at low levels of prior focus on offerings ($b = -0.175$, $t(214) = -2.863$, $p = 0.005$). At the average level of prior focus, ($b = -0.062$, $t(214) = -1.235$, $p = 0.218$), and high level of prior focus ($b = 0.052$, $t(214) = 0.730$, $p = 0.466$), secrecy was non-significant. Thus, our results support the idea that a secretive environment may not be a negative force in every situation and suggests that secrecy negatively affects intentions to focus primarily on complex digital innovations when the prior domain experience is limited.

Hypothesis 2 suggested the greater the perceived external pressure towards digital transformation, the more managers intend to focus on each domain of digital innovation, particularly when prior focus is low. External pressure was positively associated with strategic focus on all three domains of digital innovation: ($b = 0.174$, $t(198) = 3.771$, $p < 0.001$) for optimising, ($b = 0.157$, $t(198) = 3.596$, $p < 0.001$) for customer relationships, and ($b = 0.178$, $t(198) = 3.831$, $p < 0.001$) for offering. The hypothesised negative interaction was significant in Model 9 (offerings) ($b = -0.095$, $t(198) = -2.149$, $p = 0.033$), and marginally significant in Model 3 ($b = -0.082$, $t(198)$

= −1.928, $p = 0.055$) on optimisation, and 6 ($b = -0.083$, $t(198) = -1.849$, $p = 0.066$) on customer relationships. A simple slopes analysis on the interaction of external pressure and prior focus on offerings revealed that external pressure is a significant predictor of focus intentions on both low levels ($b = 0.308$, $t(214) = 5.412$, $p < 0.001$) and average levels of prior attention to offerings ($b = 0.186$, $t(214) = 4.497$, $p < 0.001$). But, at the high level of prior focus, the external pressure was non-significant ($b = 0.064$, $t(214) = 1.139$, $p = 0.256$). Thus, our results suggest that external pressure is an important driver for intentions to focus on digital innovations. This effect is especially relevant for complex innovations where prior domain experience is moderate or low.

Hypothesis 3 posited that the greater the digital breadth of capabilities, the more managers intend to focus on each domain of digital innovation, particularly when prior focus is low. However, our results did not show support for either the main effects or the interactions. Main effects ($b = -0.005$, $t(198) = -0.199$, $p = 0.842$) for optimising, ($b = 0.000$, $t(198) = -0.015$, $p = 0.988$) for customer relationships, and ($b = 0.020$, $t(198) = 0.906$, $p = 0.366$) for offering are not statistically significant. Thus, our analysis suggests that digital breadth is unlikely to help redirect top managers' focus onto digital innovation when considering the current model.

Discussion

The present study examined the antecedents of digital transformation in manufacturing SMEs, highlighting how perceived competitive pressures and intra-organisational secrecy can catalyse and hamper top management's increasing focus on digital innovation. Here, we further theorise how organisational secrecy can hamper strategic renewal both in the specific context of digital transformation and more generally.

Digital transformation as strategic renewal: the role of external pressures and transparency

Our study contributes to the study of digital transformation by adopting a strategy process perspective and drawing attention to the role of bottom-up initiatives and external pressures in reconfiguring top managers' strategic priorities. While digital transformation depends on adopting new powerful information technologies, platforms, and infrastructures (Nambisan et al., 2019), many authors have emphasised that successful digital transformation depends primarily on changes in management and organising (Kane et al., 2015; Lanzolla et al., 2018). Central to these approaches is their emphasis on the shift in managerial conceptions, often emphasised in practitioner-oriented books (e.g., Westerman et al., 2015). This shift in strategic priorities and mental models begins with a shift in attention (Kaplan, 2011; Maula et al., 2013).

As a hypothesis-testing multi-method study, this study provides merely a starting point for a strategy process approach to digital transformation. Future research should examine how internal knowledge sharing and external pressures can facilitate the development of shared cognitions concerning digital innovations (Kaplan, 2008; Schneider & Sting, 2020) and related organisational capabilities (Bingham et al., 2019; Eggers & Kaplan, 2013). In this vein, researchers could investigate digital transformation through

shifts in how managers evaluate, judge, and justify decisions related to digital investments.

We hope future studies on digital transformation and digital strategy can benefit from the survey instrument we adapted for this study. Our current instrument captures management perceptions in three distinct domains of digital innovation central to the manufacturing industry that we studied in 2015: optimisation of processes, digital customer interface, and digital offerings. Studies that apply the management cognition perspective to digital transformation in other industries can probably benefit from developing additional questions related to digital ecosystems and platforms (Cusumano & Gawer, 2002; Eckhardt et al., 2018; Gawer, 2014). While our qualitative study showed these themes to be inconsequential in our empirical setting at the time, their importance is inevitably increasing across industries.

Finally, our study has clear, practical implications for managing digital transformation in SMEs. With limited expertise and experience in digital innovations, entrepreneurial initiatives provide a central means for SMEs to explore new opportunities. While there are many ways to facilitate such exploration, our study points to the need for companies to dismantle formal and informal processes that maintain secrecy across unit boundaries and draw top management's attention to competitors to increase strategic focus on digital innovation.

Organizational secrecy as a barrier to strategic renewal

Our study contributes to the understanding of secrecy as a central and prevalent characteristic of organisational culture that may hamper strategic renewal by inhibiting the development of new ideas that would eventually filter up to the top management and influence strategy (Floyd & Lane, 2000). Building on our qualitative pre-study, we developed and tested hypotheses relating organisational secrecy to top management's strategic focus on three domains of digital innovation. The quantitative analysis supports our inductive findings, highlighting the role of open and transparent organisational culture in drawing top management's attention to new opportunities that require complex cross-functional collaboration, when prior focus on the domain of the more complex digital innovations has been limited.

Secrecy appears to be a common characteristic of organisational culture that can inhibit the ability of entrepreneurial managers to conceive, analyse, and pursue novel business opportunities. Our qualitative study suggests that organisational secrecy is not predominantly determined by organisational design (Hannan et al., 2003), the lack of effective knowledge-sharing processes (Zhou & Li, 2012), or the aggregate employee tendency to hoard knowledge (Reinholt et al., 2011; Reitzig & Maciejovsky, 2015). Instead, organisational secrecy represents a set of formal and informal processes deeply embedded in shared assumptions and social practices (Costas & Grey, 2014, 2016). In the context of our study, the manufacturing industry, secrecy was commonly evident in the lack of access to meaningful information concerning customers, sales, and costs across unit boundaries.

Our analysis suggests that secrecy has a selective effect on innovation, mainly inhibiting the pursuit of complex opportunities that span multiple departments (Mirabeau & Maguire, 2014). Prior research has suggested that secrecy may be

necessary for the early phases of practice innovations (Demir & Knights, 2021) and beneficial for incremental innovations developed within individual units (Courpasson & Younes, 2018). Here, a meaningful distinction might be made between cultures of vertical secrecy that inhibit knowledge sharing across hierarchical levels (Fang et al., 2014; Reitzig & Maciejovsky, 2015) and horizontal secrecy that inhibit the flow of information across teams. Our study captures this horizontal secrecy and shows that it inhibits the formation of complex customer-oriented entrepreneurial initiatives typical of digital transformation (Nambisan et al., 2019) and might be crucial for strategic renewal (Floyd & Wooldridge, 1999). Organizational secrecy can become a ubiquitous characteristic that constrains peer-to-peer relationships (Lane & Wegner, 1995) that are central to entrepreneurial activities and innovation (Fjeldstad & Sasson, 2010).

Organizational secrecy can be seen as a set of cultural and structural barriers to transparency, a concept that has received attention in innovation research. Prior studies have shown that transparency can help improve coordination between different organisational units (Mack & Szulanski, 2017) and mitigate information asymmetries and uncertainties (Yakis-Douglas et al., 2017). Indeed, transparency is essentially about sharing or avoiding disclosing information that may be valuable to others. A useful definition by Schnackenberg and Tomlinson (2016, p. 1788) suggests that transparency is 'the perceived quality of intentionally shared information from a sender'. While transparency is often considered an antecedent to trust (Schnackenberg & Tomlinson, 2016), trust is in turn a premise for overcoming a culture of secrecy (Costas & Grey, 2016). This suggests a promising avenue for future research related to the respective roles of trust, secrecy, and transparency in strategy processes.

Recent research provides directions for addressing some of the conditions conducive to secrecy and point towards ways for facilitating greater transparency. In these situations, company leadership would seek to create a culture of openness and minimise secretive practices. This may require addressing broader power differentials. Recently, Toegel et al. (2022) noted that top managers were likely to become secretive when middle-managers lacked power, for example due to a short tenure in their role. Moreover, the study found that middle managers became similarly secretive when top managers had centralised decision-making power. Finally, insecurity or lack of psychological safety due to experiential nature of initiatives led middle managers to become secretive. When established companies seek to engage strategic renewal processes, attending to such power imbalances nurturing organisational secrecy may help foster a more open organisational culture conducive to bottom-up generation of ideas and innovations. This seems particularly important when renewal requires complex and cross-disciplinary processes in an unfamiliar territory, as our findings show.

In the light of our findings, organisational secrecy also opens new research opportunities related to corporate entrepreneurship and strategic renewal. For example, many technology firms, such as Google, seem to strive for a significant degree of transparency and openness (Schmidt & Rosenberg, 2014; Turco, 2016). This suggests that organisational secrecy may be a central but largely overlooked impediment to the effective integration of diverse viewpoints to facilitate strategic renewal (see Vuori & Huy, 2016). Future research can further seek to distinguish the impact of horizontal and vertical secrecy and unpack

the processes of corporate entrepreneurship and strategic renewal, extending beyond the top managers' strategic focus that we investigated in our study.

Conclusion

Our study of digital transformation in the manufacturing industry draws attention to organisational secrecy (Costas & Grey, 2014, 2016) as a factor that constrains strategic renewal by inhibiting the emergence of entrepreneurial initiatives that reshape top management's focus. Our findings suggest that organisational conditions and culture, particularly around open information sharing and transparency (Schnackenberg & Tomlinson, 2016), can help 'unfreeze' the established strategy cognitions and motivate top management to prioritise issues that have been overlooked. In this respect, our study advances research on digital transformation (Autio et al., 2018; Nambisan et al., 2019) and examines digital innovation (Nambisan, 2017) in response to recent calls for advancing digital innovation (Bogers et al., 2018) within established SMEs.

Our study has several important limitations that can be addressed in future research. Because we rely on respondents' self-report measures, our measures are susceptible to social desirability bias despite our efforts to mitigate it (Arnold & Feldman, 1981). To decrease the bias, future studies could use more objective measures to capture digital transformation or explore behavioural methods for assessing how organisational secrecy shapes digital transformation. The survey design cannot distinguish the exact mechanisms through which secrecy shapes top-management priorities. While we found that top managers in less secretive companies were more likely to embrace digital opportunities, we cannot tell whether this effect derives from creating new ideas or the ability to effectively explore those ideas through entrepreneurial initiatives (Floyd & Lane, 2000). While using a cross-sectional research design in our quantitative analysis cannot rule out unobserved heterogeneity or support strong causal claims, our qualitative pre-study and post hoc examination of realised digital investments provide additional support for the negative effects of secrecy on complex digital innovations. However, a broader cross-industry analysis with longitudinal data would provide more confidence in our findings and help generalise these findings beyond the manufacturing industry.

Notes

1. The two outliers were based on failing all three cut-off points for Mahalanobsis and Cook's distances, and leverage values. We also verified the measurement model with no missing values in the dependent variable.
2. To understand why such a large set of respondents dropped out, we contacted most of the Finnish respondents who did not complete the survey. The most common reasons for dropping out were that the firm did not manufacture, conducted manufacturing abroad, or the overall topic of the survey seemed irrelevant.
3. We also created a binary variable to distinguish answers from Finland and Sweden. However, this variable correlated highly with the CEO variable (0.863 correlation significant at $p < 0.001$), creating multi-collinearity issues. All hypothesised models were run with

either the respondent's role (CEO/other) or country (Finland/Sweden), revealing that the results remained robust in both cases. Based on redundancy, and overall similarities in regulation and market environments between Finland and Sweden, we removed the country construct, and kept the respondent's role in our analysis.

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