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Exploring the programmability of management accounting work for increasing automation: an interventionist case study

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Abstract

Purpose: The purpose of this paper is to better understand management accounting automation by exploring the programmability of management accounting work.
Design/methodology/approach: We build upon the literature on digitalization in management accounting and draw upon the pragmatic constructivist methodology to understand how digitalization takes place at the individual actors' level in accounting practice. The paper uses a dataset from an interventionist case study of a machinery manufacturer.
Findings: We examine an actual process of automating management accounting tasks. During this development process, surprisingly, calculation tasks remained more fit for humans than machines though, initially, they were thought to be programmable.
Research limitations/implications: According to our findings, practitioners may interpret experts' non-programmable work tasks as programmable and seek to automate them. Only identifying the factual possibilities for automating accounting-related work can lead to automation-improved efficiency. Our findings can be increasingly relevant for advanced analytics initiatives and applications within management accounting (e.g., Robotic Process Automation, Big Data, machine learning and artificial intelligence).
Practical implications: Practitioners need to carefully analyze the entity they wish to automate and understand the factual possibilities of using and maintaining the planned automatic system throughout its lifecycle.
Originality/value: The paper shows that when processes are assessed from a distance, the non-programmable management accounting tasks and expertise can become misinterpreted as programmable, and the goal of automating them has little chance of success. It also shows possibilities for human accountants to remain relevant in comparison to machines and paves the way for further studies on advanced decision technologies in management accounting.

Keywords: management accounting, digitalization, automation, programmable, pragmatic constructivism, interventionist research
Type: Research paper

1 Introduction

The effects of digitalization on management accounting have not yet been thoroughly understood (Möller et al., 2020). To address this gap, this study analyzes the programmability of management accounting work to better understand management accounting automation. In particular, the paper examines how actors seek to improve organizational performance through new digital tools and digitalization and thus find a new purposeful way of integrating digital processes and human judgment.

In this paper, we use the term digitalization to refer to the process in which management accounting becomes more digital (Quattrone, 2016). While the term "digitalization" can have a range of meanings, in this research, we use the definition advocated by Brennen and Kreis (2016, p. 1): "the adoption or increase in use of digital or computer technology by an organization, industry, country, etc.", in this case, to support decision-making processes within the overall management accounting practice. We recognize that digitization: "the process of converting information into a digital/computer-readable format" can be a part of digitalization (ibid., p. 1).

The influence of digitalization on the accounting profession has already been a long-standing issue of debate (Scapens and Jazayeri, 2003; Al-Htaybat and von Alberti-Alhtaybat, 2017). On one hand, digitalization in accounting practices features the emergence of highly promising applications of integrated information systems, robotic process automation and advanced analytics (e.g. Lacity and Willcocks, 2015; Rikhardsson and Yigitbasioglu, 2018; Moll and Yigitbasioglu, 2019). On the other hand, automated management accounting tasks involve high risks if not used with caution (e.g., Quattrone, 2016). For example, digitalization can create a false sense of security that everything is under control when technology pervades or replaces some of the accounting-related processes that once required human intelligence (Quattrone, 2016). Disaster could occur if human labor is prematurely replaced with automation without a thorough understanding of the automized tasks and without the recognition that human and computer intelligence are profoundly different. Thus, humans must also determine the purposeful division of labor between humans and machines and how the change towards this division takes place (Bolander, 2019a, b; Möller et al., 2020). Indeed, further research is needed on the aspects in which human accountants are specifically relevant when compared to technologies that accompany, supplement or invade their workspaces (Sutton et al., 2018).

More research is needed to answer whether and how management accounting processes are "clearly defined and understood" for automation (Möller et al., 2020, p. 3), i.e. to decide whether management accounting tasks are adequately *programmed* or *routine* (cf. Emmanuel et al., 1990; Autor et al., 2003). We therefore need more knowledge on the specific types of digital expertise when deciding how accounting tasks should be executed in a purposeful manner (e.g., Viale et al., 2017; Moll and Yigitbasioglu, 2019; Oesterreich et al., 2019; Möller et al., 2020). Can we trust the digital systems to provide us with purposeful decision-making support and replace expert work in difficult, non-routine decision-making situations as they could in a situation in which the task is clearly defined and programmable (Carter et al., 2015; Quattrone, 2016)?

The purpose of this paper is to better understand management accounting automation by exploring the programmability of management accounting work. The paper explores the effort required to achieve a certain level of digitalization in management-accounting-related practices and distinguish between programmable and non-programmable expert work. As the paper shows, this distinction is not as easy to make for practitioners as one would imagine. More broadly, the paper addresses digitalization in

generating accounting numbers for managerial work and decision-making (Hall, 2010; Quattrone, 2016).

To understand what "non-routine management accounting work" means, we first depart from the idea of "routine" work within the management accounting practice. Non-routine work is something that does not follow a standardized process or flow of work and which human actors with free will can act upon based on their own reasoning, values and knowledge about reality. The localized conduct, by intentional agents, is a consequence of the local actors' reasoning about structures and practical needs in general (see e.g. Makrygiannakis and Jack, 2016). Overall, the actor constructs his/her conceptualization of reality and acts based on that conceptualization (Nørreklit, 2017). In this vein, the digitalization of management accounting involves actors integrating digitalization into their existing accounting processes by finding a purposeful way of dividing tasks between the human accountant and the machine (e.g., Möller et al., 2020).

To understand the actors' conceptualizations of their reality, one needs to access the related actors' lived experiences and the work process development within organizations (Malmi, 2016). Therefore, methodologically, the academic understanding of management accounting task automation could benefit from studies that operate at multiple levels: both at the level of the individual and the organization (Arnaboldi et al., 2017b). In this vein, in *pragmatic constructivist* studies, the individual actors are central, intentional, empowered and embedded in their context (e.g., Nørreklit, 2017). Pragmatic constructivist research acknowledges different actors' factual possibilities and values and how these are communicated in organizational life (Jakobsen et al., 2011). This also applies to whether and how the actor sees the possibility of management accounting task automation being desirable or not.

Pragmatic constructivism is a potentially interesting methodology to be used in the study of change and stability in management accounting practices.[1] This is because pragmatic constructivism can address organizations and individual actors and the actual change of practices and procedures. However, while earlier pragmatic constructivist studies that deal with digitalization (e.g., Korhonen et al., 2016) imply that managerial actors' behavioral changes do exist when digitalization comes into picture, they cannot yet explain the possible processual changes that might follow.

The research setting of the paper requires detailed observations on organizational life, practice and the related actors' intentions, factual possibilities and values, and thus engaged scholarship is favored (Van de Ven and Johnson, 2006; Jakobsen et al., 2011). Thereby, this paper uses data collected from an interventionist case study (e.g., Lyly-Yrjänäinen et al., 2017). The case study concerns the automation of pricing practices of large, complex and highly customized pieces of industrial machinery in a company operating in a niche market. More particularly, the interventionist case study thoroughly explores practices that lead to increased understanding about how management accounting tasks automation and task division between humans and machines could take place.[2]

[1] In Lukka and Vinnari's (2014) terms, our selection of focus and theoretical lenses means that our domain theory in this paper is *digitalization of management accounting practices*, which we examine through our more specific study of attempted accounting change within tendering. *Pragmatic constructivism serves as* our method-theoretical basis for this examination. Lukka and Vinnari note that contributions should be clearly targeted to domain or method theory or both.

[2] Therefore, the paper also has "a compelling theoretical dimension" that is examined through interventionist research (Scapens, 2014, p. 247) and in relation to topical academic debates (e.g., Quattrone, 2016; Möller et al., 2020).

As its empirical data collected using the interventionist case study, the paper delves into pricing-related rules and routines, which are examined at a multinational machinery manufacturing company, "TechCo", headquartered in Finland. The name "TechCo" is used for purposes of confidentiality. The interventionist case study included 31 documented meetings with 10 different persons between 2012 and 2016. The interventionist case study focused on developing pricing rules and routines at a division in TechCo. The close collaboration between TechCo's professionals and the interventionist researchers enabled the unveiling of both factual and illusionary possibilities, problems and development needs for pricing rules and routines at TechCo. Using the pragmatic constructivist approach, we show how intentional actors attempt to conduct a change towards automating management accounting tasks and eventually find a balance between human and machine labor.

TechCo's case study *shows how actors divide tasks between human accountants and digital tools* and, thereby, our paper contributes to the recent literature on digitalization in management accounting. The paper was able to examine an actual process of automating management accounting tasks. During this development process, surprisingly, pricing tasks remained more fit for humans than machines because, initially, they were thought to be programmable. More importantly, human credibility played a major role in finding the purposeful new process in which a human specialist continued to approval for each pricing case. We show that practitioners can interpret non-programmable work tasks and expertise as programmable and seek to automate them (probably with little chance of success). However, only identifying the factual possibilities of automating accounting-related work can lead to automation-improved efficiency. Computerization is associated with "sharp" declines in routine tasks, such as making calculations and keeping records, but also with increases of nonroutine tasks and interactive labor inputs (Autor et al., 2003). Indeed, the findings of this paper are a relevant and meaningful addition to the recent literature on the implications and future possibilities that digitalization incurs in the area of accounting—and in the area of management more generally.

In the following sections of this paper, we will review the relevant literature on digitalization in accounting, then go into details on our methodological choices. Empirical observations from TechCo will follow, and the paper ends with a discussion and concluding remarks.

2 Literature review: Digitalization is changing management accounting – but how?

2.1 Possibilities of automating accounting tasks

As digitalization pervades new fields, academic research needs to understand the role it plays in organizational life and, particularly, in its support role in management accounting (Quattrone, 2016; Möller et al., 2020). There is not enough academic research on the digitalization of accounting and its impact in processes performed by the finance function (Möller et al., 2020). This is the case, although many prospects for digitalization of accounting have already been identified. Academic research on accounting connects digitalization with acquiring new data and using it for decision-making (e.g., Rikhardsson and Yigitbasioglu, 2018; Moll and Yigitbasioglu, 2019; Perkhofer et al., 2020) and benefiting from, for example, earlier and deeper access to internal (Vasarhelyi et al., 2015) and external data (e.g., Chen et al., 2012; Arnaboldi et al. 2017b; Viale et al., 2017; Lassila et al., 2019; Stormi et al., 2019). Data can be more easily available from various sources (Al-Htaybat and von Alberti-Alhtaybat, 2017) and could thus support the attainment of organizational objectives (Lassila et al., 2019). Some authors connect digitalization to efficiency, efficacy and automation (e.g. Bhimani and

Willcocks, 2014; Sutton et al., 2018; Bergmann et al., 2020; Knauer et al., 2020), thus implying that digitalization changes accounting processes.

Digitalization can improve the efficiency and effectiveness of calculative processes and management control systems, e.g., by monitoring employee and manager behavior versus their performance (Warren et al., 2015). Automation of work could even lessen the necessity of monitoring employee behavior, since it aims to replace human behavior that might involve dysfunctionalities from processes (Merchant and Van der Stede, 2007; Brown et al., 2020). Automation could lead to cost savings in data generation and time savings in data analysis and verification and thus to improved capabilities for reporting and decision-making (Gärtner and Hiebl, 2018). New types of analytics, enabled by digitalization, aim to "make better business decisions rather than simply to automate standardized processes" (Nielsen, 2018, p. 168).

2.2 Challenges of automating accounting tasks

In addition to the automation possibilities, there are several challenges regarding automation and digitalization in general in accounting. These challenges include data veracity, lack of human capabilities to generate and store data, continuously increasing technology requirements and even possible loss of status of management accountants as a decision support function that processes, analyzes and verifies data (Gärtner and Hiebl, 2018; Sutton et al., 2018). Indeed, digitalization in accounting may lead to making false decisions faster (Quattrone, 2016):

> "numbers are used as mere inputs to decision-making processes with the exercising of judgment now beginning at the point when data have already been packaged and made available for consumption. Data are now 'given' to decision makers who are formally and substantially excluded from their manufacture. Decisions happen only after numbers have been recorded and management reports are often tabled rather than discussed." (Quattrone, 2016, pp. 119–120)

Raising further concern, there are several pitfalls in finding a purposeful, digitalized management accounting practice. Indeed, there is a clear distinction between human and machine intelligence, which necessitates informed task division between the human and the machine (Bolander, 2019a, b). Digitalization cannot replace the human accountant (Quattrone, 2016). Instead, we need to be concerned about the cooperation and task division between the human accountant and new technologies (see also Appelbaum et al., 2017; Moll and Yigitbasiogly, 2019): "How can the interplay between '(wo)man and machine' be designed" (Möller et al., 2020, p. 3)? We need to understand which parts of a given work role can be programmed and which cannot:

> "*programmed decision* is defined as situation where the decision is sufficiently well understood for a reliable prediction of the decision outcome to be made. A *non-programmed decision* is one that has to rely upon the judgement of managers because there is no formal mechanism available for predicting likely outcomes. That is, in programmed decisions the causes and effects are sufficiently well understood for instructions to be confidently given as to how tasks should be varied out in order to achieve a given objective. In non-programmed decisions, the causal relationships are less well understood so that it is possible only to instruct a manager as to what he is expected to achieve; the means of achievement have to be left largely in his hands […] Programmed situations can be treated as non-programmed, but the reverse is not true" (Emmanuel et al., 1990, pp. 14–15, emphasis in original).

Based on prior work, we can conclude that understanding which work tasks are non-programmed is critical for understanding how management accounting can be automated. Still, computerization can offer substitution (for routine tasks) as well as complementarities for analytic and interactive non-routine tasks (Autor et al., 2003; Arnold et al., 2004; Hyndman et al., 2014; Sutton et al., 2018; Vitale et al., 2020). Computerization can also change human workers' roles as automation's companions (Woods, 1996). Automation may well replace some experts in generating relevant data (Constantiou and Kallinikos, 2015) and thus remarkably change some aspects of some accountants' work.

Indeed, accountants' expected roles and skills may change and, as a result, less attention may potentially be paid on the reflective role of accountants in supporting complex decision-making situations. Automation could cause deskilling among accountants (Rinta-Kahila et al., 2018; Sutton et al., 2018) turning them into unquestioning followers of automation although other information would suggest otherwise (Skitka et al., 2000; Sutton et al., 2018). Indeed, linking human accountability to decisions made automatically is crucial for decision outcomes (Skitka et al., 2000). More studies on the aspects of human versus machine in the accounting field are needed, i.e. on what makes the human irreplaceable in accounting processes (Sutton et al., 2018).

Prior research shows that digitalization may alter information and decision-making processes as it can conflict with stable rules and structures by offering a fluid approach to using different kinds of data (Arnaboldi et al. 2017b). Based on empirical evidence, decision makers can also insightfully abandon digitalization-enabled tools that they do not completely understand (Arnaboldi et al., 2017a), though they may initiate the restructuring of accounting processes for the very same reason (Englund et al., 2013). Indeed, paradoxically, although systems and technologies—traditional and advanced—are often used to drive change in management accounting systems, they can create both change and stability (Hyvönen et al., 2009; Vitale et al., 2020). This is well known in management accounting research: reasons for change and stability in accounting information systems might emerge from economic/functional, institutional and individual sources (Granlund, 2001). Even work changes towards using rather basic IT could generate challenges and resistance. The clear implication is that we must make sure that we understand the kind of accounting work that is suitable for automation before jumping into conclusions about how advanced technologies could be used in the accounting profession.

Automation of data analysis (Gärtner and Hiebl, 2018) and attempts to rationalize decision-making (Arnaboldi et al., 2017b) can be seen as opportunities and threats for the accounting domain. However, empirical examinations on the digitalization in management accounting are still relatively few, although needed, to explicate which kinds of new expertise and training accounting and finance professionals would require when combining their expertise with the possibilities of digitalization (Payne, 2014; Arnaboldi et al., 2017b; Möller et al., 2020). Indeed, digitalization in developing management accounting practices remains inadequately understood, particularly on the "contextual factors", "processes, responsibilities, and IT resources" and "the roles of controllers" (Möller et al., 2020, p. 4). When we wish to understand the possibilities of the digitalization of accounting task automation, it would be important to understand the actual tasks that automation is to replace or supplement.

A longitudinal case study setting would purposeful for a more in-depth examination of the processual changes in management accounting that stem from changes in IT (Scapens and Jazayeri, 2003). In the following section, we will describe how the pragmatic constructivist approach and the interventionist case study methodology could respond to the lack of understanding about how digitalization changes

(or not) expert work processes in management accounting. Our study of management accounting automation at TechCo enables understanding how tasks can be divided between human accountants and digital tools. With our case study, it is possible to see how expert work can be surprisingly non-programmed necessitating an element of human participation in digital processes.

3 Methodology

3.1 Pragmatic constructivist approach to digitalization in management accounting

To understand how digitalization and automation change management accounting practices, we use the pragmatic constructivist approach because it is a useful approach in understanding change of practices and procedures (e.g., Nørreklit et al., 2006, p. 747, 750; Nørreklit, 2017). Based on this approach, change in an accounting practice requires values, a valid accounting logic and procedures:

> "the values must be capable of being fulfilled by (at least some of) the accounting facts and possibilities that have been established. Accounting logic and the procedures developed there-from have to enable this to happen. If this is not so, then accounting action will be compromised as practical options will not satisfy professional objectives." (Nørreklit et al., 2010b, p. 745)

In the pragmatic constructivist approach to accounting, an individual is at the center of analysis. An actor studied might well be an accountant or a non-accountant using an 'accounting logic' (e.g., Laughlin, 2010). The actor's reality is dimensioned by facts, possibilities, values and communication (Cinquini et al., 2013; Jakobsen et al., 2011; Nørreklit et al., 2010b; Nørreklit et al., 2016). It is essential that these dimensions are integrated in a setting to understand the functioning practice (Nørreklit et al., 2006; Nørreklit et al., 2010a). An actor's reality is subjective, value-driven and influenced by other actors and the context, and it evolves over time (e.g., Jakobsen et al., 2011). Therefore, the accounting logic of this actor includes his/her subjectivity and values (cf. Broadbent, 1998). Indeed, an actor (or a company) has his/her (or its) own understanding of how concepts function in practice (Jakobsen et al., 2011). An accounting statement can be considered factual only if it integrates the dimensions of facts, possibilities, values and communication (Nørreklit et al., 2016). Indeed, accounting studies should address the value dimensions of actors in introducing new accounting systems (Nørreklit et al., 2016).

The pragmatic constructivist approach offers useful tools to understand the underlying factors behind accounting practice and the possibilities to intentionally change that practice. The approach aims to understand how and why actors do what they do in some specific instances (Nørreklit et al., 2016, p. 274). This is also the case when "[m]anagement accounting goes digital" (Quattrone, 2016; Nørreklit et al., 2019). Pragmatic constructivist research acknowledges that some possibilities confronted by an actor might not be based on facts. This approach is, therefore, suitable for studying the changes that stem from digitalization in actual practice: sometimes, a change initiative fails or faces unexpected challenges. Digital tools might take out the human aspect from managerial decisions, by reducing ideas into numerical format (Nørreklit et al., 2019). Thus, for a functioning accounting practice to exist, it needs to match actors' values and needs to be communicated with adequate richness to related individuals (Nørreklit et al., 2010b; Jakobsen et al., 2011; Nørreklit et al., 2012; Cinquini et al., 2013). Validity is based on the extent to which the realization of individual values contributes to creating a functional practice from factual possibilities (Nørreklit et al., 2016). In any case, according to pragmatic constructivism, the future will tell what happens when a practice is changed and whether a possibility identified before is based on factual conditions afterwards (Nørreklit, 2017). In this vein, our

unique, longitudinal access to the development process in our case company enabled the use of the interventionist approach and the observation of the intended automation of practices through the pragmatic constructivist lens.

3.2 Interventionist case study

A qualitative case study is a valid methodological choice for this paper because understanding the change in accounting practice at a processual level necessitates observational and even participatory in-depth examination of phenomena. This way, it is possible "to understand what was said, done and understood in a particular situation" (Miller, 2007, p. 291). The paper can be labelled as an interventionist case study, since the researchers actively collaborated with TechCo's representatives in their change initiatives. Importantly, by using our qualitative and interventionist case study, we were able to witness how actors intentionally promote change towards more automatic pricing processes. By taking an active role, an interventionist researcher acquires access to meaningful research data (e.g., Suomala et al., 2014; Lukka and Suomala, 2014; Lyly-Yrjänäinen et al., 2017). The interventionist approach allows us to "closely observe the possibilities and limitations" stemming from introducing new processes (Argento et al., 2019, p. 212) with particularly strong descriptive and interpretive validity (Maxwell, 1992), stemming the longitudinal and deep access to the informants' real life and the possibility to triangulate the findings based in different kinds of data (observation, interviews, company data, calculation models). In this paper, the intervention is strong and the access to the practice is deep, as they include involvement in changes in work processes and information systems within the target organization (Lukka and Vinnari, 2017).

Our qualitative case study accesses changes in rules and routines related to pricing in a multinational machinery manufacturing company, TechCo. The viewpoint utilizes retrospection and lived experience from within the change processes. We chose the close collaboration project concerning pricing and costing at TechCo to serve as our empirical data set, because the case represents an actual, longitudinal development process aimed at changing accounting practices. The research collaboration project with the case company lasted from 2012 to 2014. The interventionist researchers' role was to provide expertise for technical work regarding the pricing change initiative.[3] As the research intervention responded to an emerging challenge, it was not possible to create a setting where a certain change was initiated and witnessed for its outcome (cf. Lyly-Yrjänäinen et al., 2017). Indeed, it was unclear what kind of change should take place. The intervention involved technical problem-solving and idea generation among TechCo's people to make the sales configuration process more efficient. Consequent check-ups were done in 2016 after the research collaboration project ended to gain additional insight about the change process. Over the whole period, 31 meetings between TechCo's people and the interventionist researchers were held to generate ideas, set targets, develop TechCo's calculative practices and review the progress of the development work. A more detailed description of each meeting and its role in data collection is given in Table I.

[3] As in Suomala et al.'s (2014) paper that depicts interventionist researchers in the battlefield of different forces where practical and theoretical work meet.

Table I. *Data collection at TechCo.*

The role of meeting	*Contact person(s)*	*Type*	*Time (m/y)*
Background understanding of TechCo's business	Product Line Director, R&D Manager	General interview on product development	5/2012
	Product Development Project Manager	General interview on product development	5/2012
	2 x Business Controller	General interview on product development	6/2012
Kick-off	Other Product Line Director, R&D Manager	Steering group for interventionist research	1/2013
	Product Manager, R&D Manager	Getting to know each other and the problem	2/2013
Legacy process mapping & target setting	Cost Specialist, Product Manager	Tender process mapping	2/2013
	Other Product Line Director, R&D Manager	Steering group for interventionist research	2/2013
	Product Manager	Idea generation	3/2013
	Product Manager, Cost Specialist	Idea generation, tender process mapping	3/2013
	Product Manager	Idea generation	4/2013
	Product Manager, Delivery Project Manager	Delivery project mapping	5/2013
	Product Manager	Informal catch-up	5/2013
	Other Product Line Director, R&D Manager	Steering group for interventionist research	5/2013
Technical development of the sales configurator	Product Manager	Database, sales configurator appearance	6/2013
	Product Manager	Early functional sales configurator testing, deciding that the original target has been reached, further idea generation	6/2013
Technical development exceeding the initial targets set	Product Manager	Feedback, further idea generation	6/2013
	Product Manager	Schedule planning, further idea generation	8/2013
	Product Manager	Catch-up on technical development work, planning of how to sell the new ideas internally at TechCo	10/2013

	Product Manager, Transportation Specialist	Investigating transportation cost drivers	10/2013
	Product Manager, Cost Specialist	Transportation cost data analysis, further idea generation, idea screening	11/2013
Sales configurator implementation	Product Manager	Preparing the sales configurator for field testing	12/2013
	Other Product Line Director, R&D Manager	Steering group for interventionist research	12/2013
	Product Manager	Preparing the sales configurator for field testing, planning the visual appearance of the sales configurator	12/2013
Reflections on the sales configurator development project	Product Manager	Feedback from field testing	1/2014
	Product Manager	Formal interview on the sales configurator development project on the paradox of embedded agency	1/2014
	Product Manager	Spreadsheet macro coding knowledge transfer from one of the two interventionist researchers to TechCo	2/2014
	Product Manager	Research seminar visit	4/2014
Further technical development outside the scope of the sales configurator development project	Cost Specialist	Transportation cost data	4/2014
	Product Manager	Transportation cost analysis, piloting a spin-off calculation tool to estimate transportation costs	4/2014
Check-up after the research project	(Former) Product Manager	Brief phone check-up	10/2016
	Cost Specialist	Brief phone check-up	10/2016
TOTAL	*10 different persons*	*31 meetings*	*Time window 5/2012–4/2016*

The meetings took place at the case company's premises and sometimes also at the university. To ensure that all significant events were documented, the researchers made detailed field notes (e.g., who speaks, what is said, direct quotes when relevant). As two researchers were present in all the meetings (except the check-ups in 2016), it was possible to further discuss the observations afterwards and, hence, to supplement the field notes. Only a few of the sessions were recorded for confidentiality and practical reasons when focusing on practical digitalization stakes (for ethnographical engagement with

informants' work, see Hammersley and Atkinson, 2007). Between the meetings and working sessions, both the researchers and TechCo's people worked towards developing TechCo's pricing-related costing tools and processes. The opportunity to become an active part of an ongoing automation initiative enabled the collection of highly relevant research data about the changes in TechCo's actual practices. The interventionist research project also allowed an ex-post analysis of the actual development work. The direct quotes that illustrate TechCo's case study originate mostly from the recorded ex-post reflections on the sales configurator development project after the technical development work had taken place.

During the analysis, the interventionist researchers identified related actors' activities and then built a process map based on the informants' accounts on the pricing of a tender. This process map was then validated within TechCo to make sure it matched their view of how they priced the tenders. Pricing routines were identified based on a triangulation between different data sources and types. The findings of the interventionist work were supplemented with interviews with TechCo's people who deal with pricing. The interventionist researchers also got access to internal company data, such as detailed material, labor and transportation costs. The researchers also utilized public data sources such as the company website and news about TechCo. Prior collaboration between TechCo and the researchers before the pricing case study also serves as background information to comprehend the background of the studied phenomenon and to validate interpretations made about TechCo's pricing rules and routines and changes therein.

4 Empirical observations

4.1 The background of TechCo's case study

TechCo is an international provider of large-scale mobile machinery. TechCo operates in the machinery manufacturing industry, which is subject to global competition.[4] Finland is a developed country that has seen the rise of digitalization and service businesses. However, there is still a relatively strong manufacturing sector. Importantly, many machinery manufacturers in Finland are export companies, which is significant to the national economy. There is, consequently, a nationwide concern about the competitiveness of the machinery manufacturing sector in Finland: high-technology products are expected to safeguard some domestic manufacturing whereas low-technology products are often outsourced from low-cost countries. White-collar engineering labor to develop this high technology is well available for machinery manufacturing companies in Finland.

Within its specific niche in the global mobile machinery industry, TechCo is a technology leader with an initiative to compete by offering high-technology customized products to its customers. The ability to customize is one of the main differentiators and a profitability driver, for TechCo. Customized machines are often preferred because the end-users of the mobile machines are businesses that utilize the machinery in their unique value creation processes. The customization of machines requires highly specific expertise both in product engineering and in costing. With its tendency to operate globally between businesses, the mobile machinery manufacturing industry is particularly sensitive to large-scale market fluctuations, such as financial crises or other global phenomena. As is the case in

[4] TechCo's specific business inside the mobile machinery industry cannot be revealed in this paper without risking the anonymity of the firm. In general, machinery manufacturers' products are typically machines or machine parts that are eventually utilized to produce or manufacture something such as goods, tasks, energy etc. Examples of machinery manufacturers are excavator, car, machine tool, paper machine, ship and boiler manufacturers.

machinery manufacturing, and more generally in Finland, TechCo's business relies heavily on exports. Before the case study was conducted, TechCo's business was not profitable enough. Over 200 employees were to be laid off after global employee cooperation negotiations that could change work assignments and cause relocations of all types of personnel. Cost efficiency was sought to increase profitability and automation of expert work was considered a possibility for cost savings. Indeed, at the financial department, there was also a pressure for increased efficiency to reduce costs. This would mean potential relocation of support staff, such as those estimating costs for tendering. Could it be possible to automate their work and thus save money – as it seemed to be a straightforward spreadsheet calculation combined with their knowledge on previous sales cases?

4.2 Sales configuration practice was largely manual at TechCo before 2013

Because TechCo competed with customized products, customers' needs also directly affected how TechCo's products were first assembled and then delivered. At TechCo, a product delivery project would roughly consist of possible order-based engineering (to make customer-specific alterations to the machine design if needed), the assembly of the ordered and specified pieces of machinery (units) and, finally, freight and commissioning. The customer-need-based variation in these phases (engineering, assembly, freight and commissioning) made it hard for TechCo's salespeople to estimate the costs absorbed in different delivery projects. Because of cost-based pricing at TechCo, the above variations would make TechCo's sales configuration process extremely critical for TechCo's competitiveness. Without functioning sales configuration, TechCo could potentially either offer their customized products at loss or set the price too high and lose a deal.

Regarding one delivered unit within a delivery project, the sales configuration process covered machine functionalities and optional features. As input to the sales configuration process, there was information about a certain possible deal (country of destination, type of machines, number of machines, schedule, customer needs regarding the machine design, etc.). The output from the sales configuration process would be the cost-based price for this possible deal. It was dedicated *cost specialists'* task to make the thorough manufacturing cost calculation for each tender, offered by a salesperson, based on the information available from the customer.

Linking customer needs accurately to TechCo's products' technical structure required in-depth knowledge, i.e. technical facts, that were provided by the cost specialist who had thorough technical expertise as well. As one critical aspect for successful sales configuration, these cost specialists would know TechCo's complex products in detail and hence be able to give a price tag for features that were interlinked with various technological subsystems (e.g. mechanical parts, electrics, etc.). They would know, for example, if a feature needs to be removed or if some contradicting feature was inserted into the delivery specification. This task, however, seemed to follow some quite understandable rules and was thought to be programmable. In practice, a cost specialist would use a huge spreadsheet to compile the product bill of materials that would stem from a feature list (engineered to order) and connect them to cost information from the enterprise resource planning system. This spreadsheet, because it was run on convenient spreadsheet software, was programmable data. The tool was developed by an expert on the sales configuration field, hereafter the "Cost Specialist". However, a person who was not accustomed to the huge and extraordinarily complex spreadsheet tool would have been overwhelmed by it. This one person, the Cost Specialist, could use the tool well, and this had been adequate for TechCo in the past.

In addition to the cost specialists, specialists in *engineering*, *assembly*, *project management*, *freight* and *finances* were also involved in supporting TechCo's sales by giving their expertise to pricing and tendering procedures. The Cost Specialist combined the cost estimates from different specialists. With this method, the whole process of answering a call for tenders took roughly a week, which appeared to be too long and person dependent. The process was too long because TechCo's personnel believed that their competitors could outrun their process. They thought that a potential buyer could invite, for example, two tenderers at the same time into a negotiation. In this kind of setting, being too slow when compared to the other tendered will make you lose the deal. Besides, the company was legally bound to deliver once the price was agreed upon with the customer, making human judgment central for accountability.

Decades ago, TechCo's project deliveries had been less complex than now. Earlier, TechCo delivered more basic and standardized machines. In these deliveries, it had been quite easy to calculate an extra cost for an extra feature (for example, an extra handle somewhere). As years passed, the need for technical understanding in sales had increased as project deliveries had become more complex, featuring up-to-date technological advancements. It was getting more difficult to calculate how much an extra feature added to the total costs. Accordingly, people at TechCo made several efforts to make sales configuration and the respective cost estimation pragmatic according to timely possibilities, resources and objectives. Earlier implemented costing tools had contributed to the quicker and timelier production of cost information and, therefore, had yielded more competitive and profitability-conscious tenders from TechCo's point of view. Before the early 2000s, sales configuration at TechCo was carried out using paper sheet calculations. After the early 2000s, spreadsheet software was introduced. Yet, experts worked manually without much automation and so did the Cost Specialist with his huge spreadsheet tool (though naturally, the Cost Specialist had developed a capability to operate the spreadsheet tool quickly, himself). Indeed, the time was spent collecting information and estimates from other specialists, not on operating the spreadsheet tool.

Figure 1 represents TechCo's sales configuration process between the early 2000s and 2013, i.e. this was the process before the change. Overall, this sales configuration process had been constructed, reconstructed and adapted over decades, and it had become the norm, the practice and the standard operating procedure at this division of TechCo.

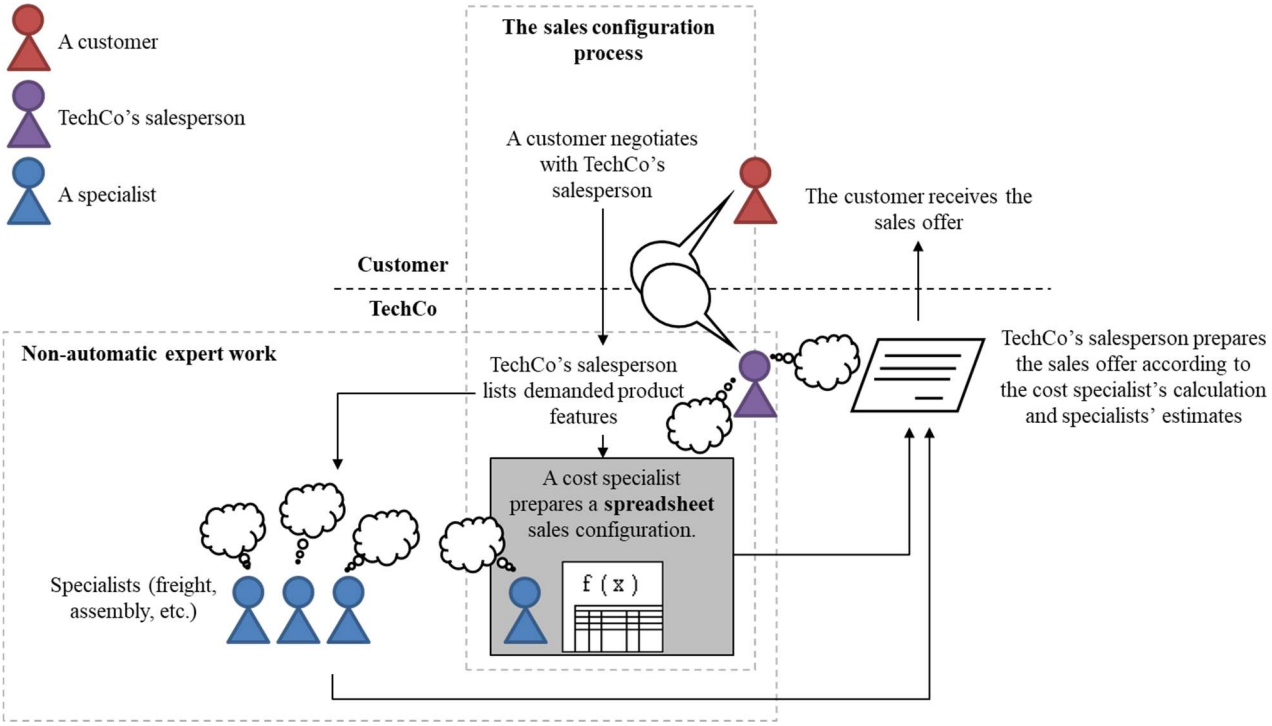

Figure 1. *A simplified illustration of TechCo's sales configuration process between the early 2000s and 2013.*

4.3 Efficiency-centrism emerges and initiates a new search for automation possibilities

During the time of the research collaboration project (2012–2014), pressures emerged to make the tendering process shorter, more cost-efficient and less person dependent. The deals were uncertain because of competing tenderers, and yet preparing each tender would consume TechCo's resources. The digital age opened ideas for a tool that would automate the price estimation of customized pieces of machinery and make it more efficient. An automatic and hence shorter tendering process was even considered to possibly increase the probability of closing deals. Therefore, a sales process redesign was initiated, now focusing on automating the sales configuration process. However, previous incremental sales configuration process redesign efforts at TechCo yielded equally resource-consuming processes and earlier attempts to *program* the sales configuration work task had failed (cf. Emmanuel et al., 1990): a requirement had remained for cost specialists' knowledge. The sales configuration process, depicted in Figure 1, represented a mindset of relying on professionals at TechCo, which also reflects the values adopted by the actors involved in the sales configuration process. The automation of sales configuration had never been attempted in a serious manner:

> *"There have been many people. Probably there have been such people that are not developers by character […] They have just found it like 'this is how it has always been done, and this is how these are calculated, and I'm calculating these [manufacturing costs] here […]' When the person, who is doing it [calculating costs], has changed, there has probably been some training, and some support in the beginning, and then [he/she] has adopted it […] currency rates [etc.] … have been added. But no radical development though." (Product Manager at TechCo)*

In contrast to the previous attempts to incrementally improve sales configuration, TechCo's personnel now recognized the need for a wider change. Previous attempts to change earlier practices at TechCo had perhaps been delayed by non-necessity to change:

> *"'The tender has always come from there, and it has always been done like that.' Until now it has been okay like that. The person [cost specialist] has occasionally changed, but somehow the operation has continued." (Product Manager at TechCo)*

During the research collaboration project in 2013, developing the sales configuration process became a possibility. Notably, a new "Product Line Director" was appointed. The Product Line Director came from outside TechCo, from another company (pseudonymously, "Company X") operating in a business somewhat like TechCo's. From his previous workplace, the Product Line Director had acquired experience on automating sales configuration, so from his point of view, automation of sales configuration was possible. However, although Company X's comparable product was also customizable, it was in many ways simpler than TechCo's products.

After the Product Line Director's appointment, the "Cost Specialist" who calculated bills of materials and compiled the cost estimations for tenders at that time (using the huge, complex spreadsheet he had developed) was reassigned to another product line in order to decrease overhead costs at the Product Line Director's division. It seemed clear that the Cost Specialist would not be available anymore for validating tender calculations, and people at TechCo perceived it necessary to change the sales configuration process to become less person dependent. It was not possible to hire a new person either since the objective was to cut costs. The cost-cutting initiative seemed evident:

> "*The company EBIT started plunging a little more than a year ago. And clearly the controllers and the management have seen that now you have to react. […] The calculation person there, it is also an overhead cost. […] A certain amount of engineers is needed in customer-based engineering, in product development, and sales and others. So, from where can you cut the overhead costs for good? Probably this [cost specialist] is a quite natural starting point. […] I guess in that they have thought very carefully how many people are needed to run the operation." (Product Manager at TechCo)*

The Cost Specialist's reassignment made it impossible for TechCo to overlook a larger-scale change in their non-automatic sales configuration practices anymore. The process depicted in Figure 1 could not have operated without the Cost Specialist.

It could be interpreted that as the EBIT was plunging, new values emerged: efficiency and quick response to customers' calls for tenders outweighed individuals' special *competences* and *expertise* because the expertise was thought to be something that could be automated or programmed (Emmanuel et al., 1990). There was a clear difference between the new values and the previous reliance on professionals. The change in sales configuration would necessarily require abandoning previous manual pricing practices that involved the Cost Specialist. Now, when changing to a different mindset, the earlier competence and authorization brought by the Cost Specialist could be viewed as a weakness and an avoidable overhead cost. Automation or programming of sales configuration could make the process more error proof and less time-consuming (cf. Merchant and Van der Stede, 2007; Brown et al., 2020) and, from the Product Line Directors viewpoint, increase cost consciousness. It appeared that the seemingly routinized expert work to calculate each tender was too expensive and reliance on experts had made tendering too person-risky:

"There were so many phases in which it [the sales configuration process] could have stopped, if the person was just [e.g.] travelling. No one else knew [about costs], because it was so person-dependent. […] If [the Cost Specialist] had been run over by a car […] The knowledge is there, but it would be a tremendous effort to build the thing up from pieces" (Product Manager at TechCo).

In other words, reliance on different specialists' expertise now became at least questionable from TechCo's point of view. Due to the Cost Specialist's reassignment that stemmed from cost-cutting, the Product Line Director's direct subordinate, a "Product Manager", was ordered to replace the legacy sales configuration process that had reflected the previous reliance on professional expertise.

Earlier, especially without the expertise of the Cost Specialist, the tender calculation could have easily yielded false information about the costs and thus TechCo's profitability potential. To know what to do and what not to do had made cost specialists' technical knowledge irreplaceable in the past – creating contradictions when shifting to the new value of efficiency-centrism from the value of professional-centrism. Previously, TechCo could operate based on expert opinions, although they were costly, risky and time-consuming. Now, TechCo's people seemed to perceive that they needed to redesign the system so that they could operate automatically without a cost specialist. The Product Manager himself was new to the sales configuration process and could easily adhere to the new value of efficiency-centrism:

"The [previous] system is not like my own dear child. On the contrary, I see myself as a mercenary, you know, my relation to this is similar: this is my duty and it gets done […] Maybe it's because I'm an outsider, I do not own the tender calculation. […] I never questioned whether something was to be done" (Product Manager at TechCo).

Overall, it was not difficult for the Product Manager to see the sales configuration process as a programmed work task or piece of expertise because he had reason to believe the process could be automated. In this phase, he could not see that the cost specialists' seemingly mundane task of using spreadsheet software in a routine manner could be surprisingly difficult to program (cf. Emmanuel et al., 1990).

4.4 Efficiency-centrism sets requirements for automation of sales configuration

The Product Line Director ordered that TechCo's previous manned sales configuration process be replaced by a new automated sales configurator that had been inspired by the Product Line Director's experience from Company X's automated sales configurator. At this point, the Product Managers at TechCo understood that the sales configurator could be based on something that was already functional elsewhere, i.e. they seemed to show mimicry.[5] The example from Company X also made the shift towards automated sales configuration (perceived) believable:

I clearly see that when this [sales configuration] has been discussed – especially in the early phase, January–February last year – […] little before you [interventionist researchers] came along, I put forward different kinds of ideas about what this could be. Everything sounded good but I clearly noticed that [the Product Line Director] wanted to take this quite close to the [Company X]'s model anyhow. So, no purchasing [the sales configurator] from an IT-company. Like that. And 'no this, no that.' 'That's enough'. […] clearly, the influence of the [Company X]'s model has been strong. But then again, why not? If they had seen it was workable and they

[5] For more on mimicry, please see Lawrence and Suddaby, 2006.

had used it for a long time, and theirs was a configured product like ours. (Product Manager at TechCo)

At TechCo, the shift from professional-centrism to efficiency-centrism required a communicated shift of values and factual conditions, i.e. internal selling, and especially TechCo's and the interventionist researchers' work to make sales configuration follow some guidelines from the Product Line Director's previous workplace, Company X.

In the past, the sales configuration process had been a collaboration of individuals, resulting in an approved calculation that could be used in preparing tenders (dozens of times a year). Professional-centrism had meant that calculations had been burdensome to prepare by knowledgeable individuals, but they were perceived as reliable. Nevertheless, professional-centrism was deeply rooted in TechCo's organizational culture and worries against digitalization of cost accounting were prevalent. Earlier commentators had given the impression that cost specialists' expertise might be non-programmable (Emmanuel et al., 1990):

"*Many say that 'you can't do this,' there are so many people involved who have some unique competence that you can't do like that, 'you have to ask the people.' Like 'they have the data on their computers, and you can't get an access there, and can't do it that way'" (Product Manager at TechCo).*

During 2013, the Product Manager, together with the interventionist researchers, built a spreadsheet-software-based sales configurator that was presented to the Product Line Director. The Product Manager examined the possibilities of defining the manual interlinkages between product features and technical structure in a database that would enable listing all the standard and possible features for a specific product type. It was found that there already was a database platform available in the company – a platform that was capable of transferring data with the spreadsheet software used. Importantly, the cost data maintenance was thought to be automated from TechCo's information systems to this database (afterwards, however, this possibility was discovered to not have been factual).

Simultaneously with the Product Manager's task of building the database, the interventionist researchers developed a new spreadsheet tool that would communicate with the database. The connection of features and material costs was made to show as simply to the user as possible. This simplicity required spreadsheet macro *programming* (cf. the workflow was literally "programmable" in terms of Emmanuel et al., 1990). Once the macro programming and, consequently, the spreadsheet development was accomplished, the initial task given by the Product Line Director was seemingly fulfilled: sales configuration was thought to be automated using a simple, appealing digital tool, and it could also be used by people other than those with a cost specialist status. Expert knowledge had seemingly been transformed into routine, programmed work.

Figure 2 illustrates the targeted new sales configuration rules, now introduced for tendering at TechCo as an answer to the Product Line Director's order, developed in cooperation between the Product Manager, the reassigned cost specialist and the interventionist researchers. Figure 2 illustrates the intended process after change.

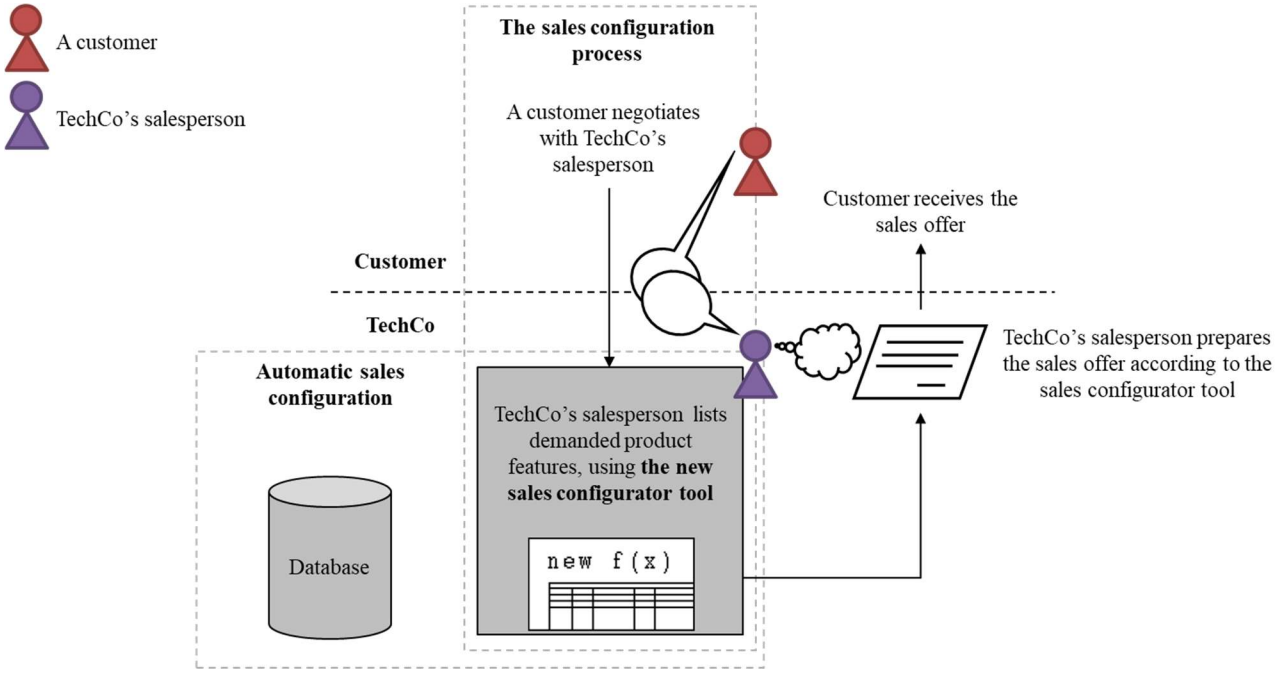

Figure 2. *A simplified illustration of TechCo's intended sales configuration process developed in 2013.*

4.5 The new sales configuration process – the illusion of task programmability is revealed

At the end of 2013, TechCo launched the new sales configuration process for testing in real-life customer cases. The sales configurator was implemented as an attempt to decrease reliance on cost specialists' expertise at TechCo. A new, more automatic process was introduced to reflect the values according to which sales configuration should be efficient, automatic and quick. Accounting facts regarding pricing were deemed less uncertain than they had used to be. Automation was thought to yield a legitimate process:

> "*We are clearly transitioning, via the configurator, to a mode in which at least the calculation must be clear: where the price comes from, and from which parts it consists of, and how this takes place" (Product Manager at TechCo).*

In summary, change drivers, such as cost pressures and the need for efficiency, were identified at TechCo. As a result, actors' intrinsic values and motivations to change the previous sales configuration process surfaced, underlining the need for change. Internal selling took place in the form of promoting change and empowering actors to overcome the incompatibility of the previous sales configuration process, guided by the new value of efficiency-centrism. This internal selling was also backed up by TechCo's need to decrease person-dependence and professional-centrism and by the construction of the new sales configurator developed together with the interventionist researchers.

However, after the implementation of the new sales configurator system, large deals were still witnessed to be authorized by the Cost Specialist to avoid business risk, although he was indeed working elsewhere inside TechCo. The Product Manager would make his calculation using the new sales configurator, while the same Cost Specialist would use the prior spreadsheet calculation, and the management would decide a deal based upon both media. The new system became a new layer, a sediment on top of the previous system (Hyndman et al., 2014).

In the beginning of 2014, it was evident that the adaptation of the new sales configurator was an ongoing process rather than an event; the acceptance of the new mode of working did not take place overnight. The goal of an automated sales configuration process had not yet been reached as quickly as anticipated. In fact, during the transition phase, pricing support required more labor than with the previous sales configuration process (Figure 1). Disruption of the legacy sales configuration process was only partial and had resulted in a parallel, layered system.

Indeed, there still seemed to be ambiguity about which values TechCo's operations should comply with, and hence conflicting values persisted. The noncompliance of practices with the previous values and especially some unexpected facts hindered a quick shift from professional-centrism to efficiency-centrism. These facts included the following: TechCo's operations could not mimic Company X's operation, since they were, anyway, too different. Legally, the binding strength of tendering calculations had not decreased, as had not TechCo's product complexity. Moreover, in 2016, it became evident that the automatic data maintenance from TechCo's information systems to the implemented sales configurator had not succeeded. Automatic data maintenance had not been possible in the very beginning. Furthermore, to take away the ownership of the new sales configurator, the Product Manager was transferred to another position, the Product Line Manager was promoted, and the interventionist researchers were needed elsewhere. Now, there were no more powerful actors promoting the new value of efficiency-centrism regarding sales configuration. The Cost Specialist still needed to – and he still could – calculate absorbed costs for pricing, although less frequently than before. His expertise could not be automated, but automation was not necessary either because he could lend a hand when needed.

Altogether, the process of sales configuration was too complex and ambiguous for full automation, but this could not be seen beforehand: a seemingly logical and programmable exercise turned out to be a non-programmable one, which was somewhat surprising to the eager proponents of automation at TechCo. Importantly, what was now attempted to be digitized and eventually automated was not as routine work as it was thought to be. It was a piece of highly professional expert work (Autor et al., 2003). The most non-programmable element seemed to be the human authorization given by the Cost Specialist to each tender, although difficulties to automate concerned more technical aspects as well, e.g. data maintenance and freight cost estimation.

The new sales configurator was abandoned, but importantly, practices at TechCo had also found a new purposeful flow regarding the resources now available. The Cost Specialist could still be used for sales configuration calculation. TechCo's period of obvious value contradiction propelled the case company to reevaluate what kinds of more automated practices would serve its current needs but ended up with a process that was much like their starting point. This might be the most purposeful choice for TechCo, since automating tasks that are not programmable could lead to faster but false decisions (Quattrone, 2016; Arnaboldi et al., 2017b; Gärtner and Hiebl, 2018).

As a key message, based on our empirical evidence, we posit that the automation of management accounting tasks is risky and requires caution and deep understanding of the tasks under question. There might be a risk of seeing automation possibilities where they do not factually exist. Illusions of non-programmable tasks being programmable could lead to counterproductive developments or, as in TechCo's case, returning to the starting point. Table II makes a summary of TechCo's case study in the light of pragmatic constructivist dimensions of reality (facts, possibilities, values and communication) and thereby lays ground for our discussion and conclusions section.

Table II. *Summary of TechCo's case study – drivers and barriers of sales configuration automation.*

	Before 2013	*In 2013*		*After 2013*
Drivers of sales configuration automation	**Facts:** Paper sheet calculations were replaced by spreadsheet software.	**Facts:** Overhead costs of the Cost Specialist. A new Product Line Director nominated. A new Product Manager nominated to automate tendering calculation. A development project with interventionist researchers provided much needed development resources for tender calculation automation. The Cost Specialist was relocated elsewhere inside TechCo. Some parts of the Cost Specialist's work was de facto programmed (as spreadsheet macros). **Values:** Mindset of efficiency and quick response to customers. Emergence of development mentality.	**Possibilities:** Automatic tender calculation could be quicker and more precise. Decreasing the person risk related to the Cost Specialist. Increasing the probability of sealing a deal. Imitating Product Line Director's previous workplace (non-factual). Perceived necessity to change the tendering process (non-factual). An IT platform for data maintenance was thought to be available (non-factual). Relocating the Cost Specialist and thus saving overhead costs. **Communication:** The tender calculation had been communicated at TechCo to be a relatively programmed task (illusion). Communicating the shift of values and factual conditions. Internal selling of the new sales configuration process.	
Barriers of sales configuration automation	**Facts:** Complexity of products increased. Company legally bound to tender calculations. Attempts to program cost specialists' work had not succeeded. **Possibilities:** No necessity to change. **Values:** Relying on professionals and their validation. Lack of development mentality. Worries against digitalization of cost accounting.	**Facts:** TechCo's product complexity had not decreased. Binding strength of the tender calculation had not decreased.		**Facts:** IT system maintenance demanded more resources than expected. Active cooperation with the interventionist researchers ended. The Product Manager relocated. The Product Line Manager promoted. **Possibilities:** Relocation of the Cost Specialist seemed not to be as absolute as perceived earlier. **Values:** Reliance on valid and legitimate authorization by human actor.

5 Discussion and conclusions

The purpose of this paper was to better understand management accounting automation by exploring the programmability of management accounting work. To reach this goal, we built on topical literature on digitalization in accounting. Furthermore, we found pragmatic constructivism helpful to understand why people act as they do, particularly when they attempt to automate processes. Pragmatic constructivism added clear value to identifying and examining factual and illusionary possibilities regarding management accounting task automation. We examined TechCo's attempt to shift from professional-centrism to efficiency-centrism in their sales configuration and pricing. Understanding this shift benefited from our in-depth, interventionist case study that thoroughly examined TechCo's sales configuration process. Such findings could have hardly been seen from a distance (e.g., Lyly-Yrjänäinen et al., 2017). Our piece of research that examined accounting where it is being developed could show the drivers and barriers of management accounting task automation as an example of a managerialist study of accounting (Malmi, 2016). Next, we will discuss the contributions of the paper.

5.1 The contribution of the paper

The core contribution of the paper is that sometimes, when the processes in question are assessed from a distance, practitioners can interpret non-programmable work tasks and expertise as programmable ones and seek to automate them with little chance of success. The surprisingly tricky thing – as TechCo's case study shows – is to determine whether an expert's work task could be automated, i.e. whether it has programmable elements (Emmanuel et al., 1990). Our findings indicate that cost-related expertise can be surprisingly non-programmable even in situations in which data is thought to be structured – and is hence subject to misinterpretation (non-factual possibilities, cf. Jakobsen et al., 2011; Nørreklit et al., 2016; Nørreklit, 2017). At TechCo, it became clear that the pricing-related work entails not just making calculations for decision-making. Comprehending this, and the fact that those powerful actors that used to promote the new system left the pricing operations, contributed to the abandonment of the new more automatic system (cf., Arnaboldi et al., 2017a). The paper shows that although efficiency is easily desired in organizational life, actors need to find factual possibilities for automation to acquire efficiency gains

The findings imply that although digitalization can mean automation of analytical work, practitioners need to be cautious not to attempt programming non-programmable processes, which is impossible (Emmanuel et al., 1990). This is highly important to understand when more advanced forms of analytics are implemented into management accountants' work so that faster but not false decisions are done as mentioned earlier (Quattrone, 2016; Arnaboldi et al., 2017b; Gärtner and Hiebl, 2018; Al-Htaybat and von Alberti-Alhtaybat, 2017). In TechCo's case, parts of the cost specialists' pricing task could indeed be automated once a sales configurator was programmed (cf. spreadsheet macros and database integrations in TechCo's case). This way, the pricing task was not entirely non-programmable. However, the cost specialists' role *per se* could not be automated, and once he could surprisingly continue supporting the pricing practice, there was no need for automation anymore. However, based on our thorough examination of TechCo's practice, we argue that the cost specialists' work task was so complex that automating this task would have required huge amounts of master data management, together with the definition and maintenance of accounting rules. The sales configurator and the process that was developed lacked those properties as well as sufficient human capability to care for accountability of pricing decisions (cf. Skitka et al., 2000; Carter et al., 2015).

The significance of the outlined core contribution stems from the following aspects, that all have both theoretical and practical relevance:

1. showing the need to understand digitalization as a context-dependent phenomenon,
2. increasing understanding on the challenges of gaining efficiency by accounting automation,
3. showing possibilities for human accountants to remain relevant in comparison to machines and
4. paving the way for further studies on advanced decision technologies in management accounting.

Now, we will discuss the meaning and theoretical implications of each of these aspects. First, by providing empirical evidence of a management accounting automation attempt, our paper connects to the literature that deals with digitalization in (management) accounting. In our empirical case study, the changes were only temporary and yielded a temporary supplement rather than a replacement of the original sales configuration process (cf. Hyndman et al., 2014). As our case study operates both at the level of the individual and the organization (Arnaboldi et al., 2017b) – by examining the automation intentions at TechCo as an organizational goal and as individual managers' initiative – it was able to unveil value conflicts when TechCo attempted to move from professional-centrism to efficiency-centrism. Although some earlier empirical studies on this area exist, they are still scarce (Möller et al., 2020). As often the case with empirical examinations, also ours required thorough understanding of the studied context. Understanding the overall situation thoroughly allowed us to understand why it was difficult to automate a management accounting task in this case. For this reason, we believe that when studying digitalization, authors need to be aware that it is a phenomenon that is context-dependent (Van der Stede, 2016). Without the details, many important aspects might be missed, and contemplation of digitalization could remain rather superficial. Would our findings be applicable to other contexts then? We claim yes, with careful consideration. By studying digitalization and automation more specifically in context, we saw their driving forces and hindering factors, which could be present also in other contexts. Further empirical evidence is, however, needed. Particularly, we encourage future studies to examine the possible behavioral and institutional aspects that result from the challenges in identifying programmable or non-programmable management accounting tasks in different contexts.

Second, the paper shows that automation does not necessarily lead to cost efficiency, at least not when non-programmed decision-making and professional expertise are in question. Automation will provide new possibilities for redesigning business processes, but not everything can be digital. Shifting work tasks from humans to machines seems not to take place overnight either and might not take place in the end after all. Rather, cost savings might be virtual (relocation of a person) or even counterproductive (overlapping work) as TechCo's case study showed. However, TechCo found a purposeful way to run the sales configuration process, as they found out that the "lost" human resource (Cost Specialist) was not completely lost after all but could still be used to give insight and validation for tender calculations. Indeed, TechCo's case study showed that after the restructuring process, not much changed. The change in process was only virtual in this case. These findings contribute to the literature on digitalization in the accounting profession by suggesting that digitalization or automation does not necessarily mean more efficient processes. This suggestion contradicts with some earlier studies (cf. Bhimani and Willcocks, 2014; Warren et al., 2015; Al-Htaybat and von Alberti-Alhtaybat, 2017; Gärtner and Hiebl, 2018; Sutton et al., 2018; Bergmann et al., 2020; Knauer et al., 2020). As our study provides a clear inconsistency to this stream of literature, we suggest that more research should be conducted to unveil the actual process implications of management accounting automation. This should build a more factual basis and possibilities for efficiency gains from work automation. Without the factual possibilities (Jakobsen et al., 2011; Nørreklit et al., 2016; Nørreklit, 2017), automated practices

might return to prior logics and processes (Arnaboldi et al., 2017a).[6] As in this case, automation possibilities were not factual; they were ultimately illusionary (Jakobsen et al., 2011; Nørreklit et al., 2016). We therefore suggest research on how organizations construct factual possibilities regarding digitalization and automation, and thus how actors together enact digitalization and automation (e.g., Nørreklit et al., 2019).

One possible explanation for the unrealized efficiency potential is the idea of layering in Hyndman et al. (2014), which means that the new and more digitalized practice becomes supplementary (i.e., a new layer), even if it was originally conceived as a replacement for the previous practice. This idea resonates with earlier findings about computerization complementing analytic and interactive non-routine tasks (Autor et al., 2003; Arnold et al., 2004; Vitale et al., 2020). TechCo's people sought to substitute manual practices, yet ending up first with overlapping practices as the Cost Specialist and Product Manager calculated the same things, and later, abandoning the automatic sales configurator (Arnaboldi et al., 2017a). The cost-saving initiative explains why TechCo's practitioners tended to see the process from a replacement point of view and underemphasized the necessity to understand the actual basis of efficiency in their current processes, which anyway, were changing due to changes in resources available. Indeed, changes in TechCo's organization and actors' responsibilities also meant that the task automation effort had to take place in a quite dynamic situation – which we believe is the situation often. In the end, organizing practices changed more than the mindsets or tools at TechCo (cf. Vitale et al. 2020) as the relocated Cost Specialist continued to perform as an external consultant who validated the tender calculations. Other reasons for abandoning the new system included its technical imperfection (data maintenance) and incapability to provide similar human authorization for tenders (as the previous system had) (Woods, 1996; Skitka et al., 2000; Granlund, 2001; Carter et al., 2015). All these reasons contribute to contextual understanding about how machines and humans share roles (Quattrone, 2016; Appelbaum et al., 2017; Bolander, 2019a, b; Moll and Yigitbasiogly, 2019; Möller et al., 2020). This question, however, is still necessary for the future research – and needs to be further addressed by longitudinal studies and qualitative inquiry that explain how and why accounting task automation might or might not be purposeful in specific situations. Again, we come back to the necessity of understanding the context and thus not discussing 'digitalization' at the general level only.

Third, another contribution of this paper is related to the earlier studies on the effect of digitalization on the accounting profession. Our findings add insights into the debate about the kinds of new expertise and training that accounting and finance professionals would require in the future (Payne, 2014; Arnaboldi et al., 2017b; Moll and Yigitbasioglu, 2019). Reliance on the expertise of professionals will continue as circumstances for that require them remain (Malmi, 1997; Granlund, 2001). When human labor is automated, practice changes, but as the case study shows, digitalization itself cannot drive change. We can speculate that, overall, fewer accountants might be needed as transaction data can become linked to physical processes and as some basic reconciliations can be automated. However, at the same time, more accountants are needed to control and develop those tools and related processes. In TechCo's case, this aspect was left for too little attention, as the intention to make the process more efficient prevailed and the practitioners did not carefully examine the parts of the work that could be purposefully automated. For instance, we can argue that focusing on rather basic robotic process automation of transferring data from a system to another could have been more purposeful. In hindsight, the first automation steps could have been rather simple. For instance, automating the cost of an item could come directly from the ERP system to the spreadsheet rather than manually exporting

[6] Although novel in the area of digitalization in accounting, this suggestion resonates with some earlier findings about management accounting change and stability (e.g., Malmi, 1997; Granlund, 2001; Major, 2007; Hyvönen et al., 2009).

that data. This would have helped the Cost Specialist to do his work more efficiently. However, the seemingly necessary effort to replace the relocated Cost Specialist with a spreadsheet tool perhaps focused TechCo's and the interventionist researchers' development work towards too direct automation of the Cost Specialist's work role, which was too ambitious at that time.

The paper shows that the automation of work processes that require overly complex accounting-related and/or technical expertise requires significant support from IT infrastructures. This is no news (cf. Granlund, 2001; Gosain, 2004; Hyvönen et al., 2009) but is an important reminder. We would even suggest that the automation of 'expert work' might not be credible without serious attempts to utilize artificial intelligence, machine learning or advanced analyses of that type, although we would remain cautious not to misuse machine intelligence (cf. Bolander, 2019a, b). All these advanced technologies are rather extreme examples of work and process automation that digitalization can offer. In TechCo's case, even proper database connections and integrations could have "saved" the tool, as postulated above. The case highlights both the gradual nature of digitalization and the fact that much of digitalization in the organizations is still happening on the lower technology tiers. Furthermore, we argue that the role of the Cost Specialist was not only to calculate the costs but also to handle the related uncertainties. He had some implicit knowledge that was not recorded on any IT system. A possible implication of omitting this implicit knowledge from tender calculations, for instance, is that the time needed for machine testing could probably increase. In this case, the work of mitigating uncertainties would be transferred to the technical testing of the product. Without the Cost Specialist, TechCo would lose some discussion between actors when they discuss the manufacture of numbers (Quattrone, 2016).

Having said that, technological advancements have turned various types of expert work into non-human processes with good results. Let us take eye surgery as an example. An automatic laser cuts a patient's eye with considerable precision. What is different regarding a cost specialist at TechCo? Again, we claim that the answer is in the non-programmable nature of the Cost Specialist's work (Emmanuel et al., 1990), which features several organizational interfaces, a combination of technical and financial skillsets, and surprisingly complex decision-making situations. The Cost Specialist's task was not essentially to decide but to authorize tenders by using his interdisciplinary expertise that he was credited with. This piece of findings has an interesting implication: TechCo's case study suggests that hybrid accountants (Kurunmäki, 2004) could be a potential group of experts whose accounting-related expertise will not be easily automated. Hybrid accountants have a complex understanding of both accounting and other relevant subject areas. This implication is a direct contribution to the prior call for examining in which aspects humans in accounting are especially needed when compared to machines that could potentially do their work (Sutton et al., 2018). This implication, however, necessitates future research in hybrid accountants' work task complementation, overlapping and substitution by computerization (Autor et al., 2003; Arnold et al., 2004).

Fourth, and as indicated above, while our case study deals with a change initiative of a non-programmed work task in pricing, it can open interesting ideas for further studies on advanced decision technologies in management accounting (Big Data and other highly advanced technologies are increasingly studied in accounting research). To be more specific, research expects changes in accounting due to digitalization but understanding about changing decision processes due to digitalization remains inadequate. This paper raises the concern that if automation of common tasks is so difficult in practice because they are more complex than seems on the surface, perhaps academics should anticipate reluctance towards more advanced analytics as well. We understand that spreadsheet

software does not represent the state of the art in current IT systems. However, spreadsheets often do represent the first pilots to implement a new idea to be analyzed quantitatively and, even after some time, they can be found to have earned their place among practices.

Are non-programmed decisions precisely the area where advanced analytics hold the most potential in helping to make sense of unstructured data (Bolander, 2019a, b) – and if so, how and which kind of implications follow? Or is it the case that the most well-known, simple and repetitive accounting-related tasks represent the lowest hanging fruit for automation in management accounting? And again, if so, what are the implications of such findings? We suggest that future researchers attempt to answer these questions. At TechCo, the goal of automation was perhaps a bit too ambitious: rather than automating a task, the goal was to automate almost the whole sales configuration process. Opinions exist that the next wave of machine-learning-driven automation can surpass such issues (Brynjolfsson and Mitchell, 2017; Mitchell and Brynjolfsson, 2017), but our findings resonate with the belief that future accounting research needs to critically examine this currently developing area (e.g. Rikhardsson and Yigitbasioglu, 2018; Bolander, 2019a, b; Moll and Yigitbasioglu, 2019; Möller et al., 2020). Future research is also needed in the area of advanced analytics to understand management-accounting-related practice changes therein. For instance, are our findings from the context of customized products in the business-to-business, for-profit sector applicable to other types of environments, e.g. the business-to-consumer market, services, public administration, non-profits etc.? Future research is needed to examine this.

5.2 Managerial implications

Our case study suggests that pricing systems need to be adequately accessible, modifiable by users (not only administrators), equally destroyable (with low technological or systemic lock-in) and their developers knowledgeable of the possible false sense of change in system development. The paper demonstrates how digitalization in management accounting practices requires facilitation in order to establish new processes (that are more automatic): technological development, training, technical support, information system integration and maintenance in addition to the organizational mandate to execute a change initiative (cf. Munir et al., 2013). Practitioners need to carefully analyze the processes they wish to automate and understand the factual possibilities of using and maintaining the planned automatic system throughout its lifecycle, i.e., whether the possibilities for automating those processes are factual or illusionary. Without proper support and maintenance, the tools once enabled by digitalization might not answer information users' changing demands and thereby fail to give useful results for their managerial purposes later. Moreover, while many tasks can be automated, automating the decision – i.e. taking the correct inputs from all preceding tasks and turning them to a feasible output – can be still too challenging without a human actor.

Therefore, it seems that in order to succeed in a change initiative, managers should direct attention towards whether a task is programmed or non-programmed (Emmanuel et al., 1990) and whether the information systems at hand actually enable the automation of some related accounting processes. Finally, managers need to pay attention to the types of digitalization their operations link to; whether it is automation or something else that is needed. Organizations need to carefully consider whether they strive for efficiency or productivity: as automation can release accountants' time from easy-to-automate tasks to increasingly complex and skill-demanding judgments and interpretations.

5.3 Limitations

Our findings drawn from the sales configuration development work in TechCo's context (post-financial-crisis machinery manufacturing, pricing of customized products, in Finland may well hold implications for some other contexts as well. Our case study can be seen in the "real life" of accounting and managerial work – of which our case study with TechCo is an example. The development work that TechCo's people and the interventionist researchers carried out, in contrast, is highly unlikely to fit in some other real-life context on an "as is" basis. Future studies could well examine different forms of digitalization in different accounting work automation contexts (cf. Messner, 2016). However, our case study with TechCo was able to unveil some contextual characteristics of the digitalization of accounting as called for recently (Möller et al., 2020).

5.4 Concluding remarks

By investigating quite a mundane type of digitalization, i.e. automation in pricing processes, this paper brings up issues that are quite possibly applicable to many environments and increasingly so when more advanced types of digitalization are in question, i.e. Robotic Process Automation, Big Data, artificial intelligence, machine learning, etc. Indeed, TechCo's case represents possible challenges in automating management accounting work using even commonly known spreadsheets that many professionals still at least partly rely on. The case further underlines the need to challenge our assumptions on how well we can identify programmable and non-programmable tasks, when more advanced forms of digitalization – which might not be as commonly known among practitioners as spreadsheets – are concerned. This is a fruitful area for future research.

6 References

Al-Htaybat, K., von Alberti-Alhtaybat, L. 2017. Big Data and corporate reporting: impacts and paradoxes. Accounting, Auditing & Accountability Journal, 30, 850–873.

Appelbaum, D., Kogan, A., Vasarhelyi, M., Yan, Z. 2017. Impact of business analytics and enterprise systems on managerial accounting. International Journal of Accounting Information Systems, 25, 29–44.

Argento, D., Grossi, G., Jääskeläinen, A., Servalli, S., Suomala, P. 2019. Governmentality and performance for the smart city. Accounting, Auditing & Accountability Journal, 33, 204–232.

Arnaboldi, M., Azzone, G., Sidorova, Y., 2017a. Governing social media: the emergence of hybridised boundary objects. Accounting, Auditing & Accountability Journal, 30, 821–849.

Arnaboldi, M., Busco, C., Cuganesan, S. 2017b. Accounting, accountability, social media and big data: revolution or hype? Accounting, Auditing & Accountability Journal, 30, 762–776.

Arnold, V., Collier, P. A., Leech, S. A., Sutton, S. G. 2004. Impact of intelligent decision aids on expert and novice decision-makers' judgments. Accounting & Finance, 44, 1–26.

Autor, D. H., Levy, F., & Murnane, R. J. 2003. The skill content of recent technological change: an empirical exploration. The Quarterly Journal of Economics, 118, 1279–1333.

Bergmann, M., Brück, C., Knauer, T., Schwering, A. 2020. Digitization of the budgeting process: determinants of the use of business analytics and its effect on satisfaction with the budgeting process. Journal of Management Control, 31, 25–54.

Bhimani, A., Willcocks, L. 2014. Digitisation, 'Big Data' and the transformation of accounting information. Accounting and Business Research, 44, 469–490.

Bolander, T. 2019a. Human vs machine intelligence. Proceedings of Pragmatic Constructivism, 9(1), 17–24.

Bolander, T. 2019b. What do we lose when machines take the decisions? Journal of Management and Governance, 23, 849–867.

Brennen J., Kreiss D. 2016. The international encyclopedia of communication theory and philosophy. John Wiley & Sons, Inc., pp. 1–11.

Broadbent, J., 1998. The gendered nature of "accounting logic": pointers to an accounting that encompasses multiple values. Critical Perspectives on Accounting, 9, 267–297.

Brown, P., Ly, T., Pham, H., Sivabalan, P. 2020. Automation and management control in dynamic environments: managing organisational flexibility and energy efficiency in service sectors. The British Accounting Review, 52, 100840.

Brynjolfsson, E., Mitchell, T. 2017. What can machine learning do? Workforce implications. Science, 358(6370), 1530–1534.

Carter, C., Spence, C., Muzio, D. 2015. Scoping an agenda for future research into the professions. Accounting, Auditing & Accountability Journal, 28, 1198–1216.

Chen, H., Chiang, R.H., Storey, V.C. 2012. Business intelligence and analytics: from big data to big impact. MIS Quarterly, 36, 1165-1188.

Cinquini, L., Mitchell, F., Nørreklit, H., Tenucci, A. 2013. Methodologies for managing performance measurement, in Mitchell, F., Nørreklit, H., Jakobsen, M. (Eds.), The Routledge companion to cost management. Routledge, Abingdon, Oxon, New York, 360–380.

Constantiou, I.D., Kallinikos, J. 2015. New games, new rules: big data and the changing context of strategy. Journal of Information Technology, 30, 44–57.

Emmanuel, C.R., Otley, D.T., Merchant, K.A., 1990. Accounting for management control, 2nd ed. Chapman and Hall, London.

Englund, H., Gerdin, J., Abrahamsson, G. 2013. Accounting ambiguity and structural change. Accounting, Auditing & Accountability Journal, 26, 423–448.

Gärtner, B., Hiebl, M.R. 2018. Issues with Big Data, in Quinn, M., Strauss, E. (Eds.), The Routledge companion to accounting information systems. Routledge, 161–172.

Gosain, S. 2004. Enterprise information systems as objects and carriers of institutional forces: the new iron cage? Journal of the Association for Information Systems, 5, 151–182.

Granlund, M. 2001. Towards explaining stability in and around management accounting systems. Management Accounting Research, 12, 141–166.

Hall, M., 2010. Accounting information and managerial work. Accounting, Organizations and Society 35, 301–315.

Hammersley, M., Atkinson, P. 2007. Ethnography: principles in practice, 3rd ed. Routledge, London & New York.

Hyndman, N., Liguori, M., Meyer, R.E., Polzer, T., Rota, S., Seiwald, J. 2014. The translation and sedimentation of accounting reforms: a comparison of the UK, Austrian and Italian experiences. Critical Perspectives on Accounting, 25, 388–408.

Hyvönen, T., Järvinen, J., Pellinen, J., Rahko, T. 2009. Institutional logics, ICT and stability of management accounting. European Accounting Review, 18, 241–275.

Jakobsen, M., Johanson, I., Nørreklit, H. 2011. An actor's approach to management conceptual framework and company practices. Djøf/Jurist-og Økonomforbundet.

Knauer, T., Nikiforow, N., Wagener, S. 2020. Determinants of information system quality and data quality in management accounting. Journal of Management Control, 31, 97–121.

Korhonen, T., Stormi, K., Laine, T., Liew, A. 2016. Examining technical and behavioural possibilities in developing fleet services in the machinery manufacturing context. Proceedings of Pragmatic Constructivism, 6, 3–13.

Kurunmäki, L., 2004. A hybrid profession: the acquisition of management accounting expertise by medical professionals. Accounting, Organizations and Society, 29, 327–347.

Lacity, M., Willcocks, L. 2015. What knowledge workers stand to gain from automation. Harvard Business Review, June 19, 2015.

Lassila, E.M., Moilanen, S., Järvinen, J.T. 2019. Visualising a “good game”: analytics as a calculative engine in a digital environment. Accounting, Auditing & Accountability Journal, 32, 2142–2166.

Laughlin, R., 2010. A comment on “Towards a paradigmatic foundation for accounting practice”. Accounting, Auditing & Accountability Journal, 23, 759–763.

Lawrence, T.B., Suddaby, R., 2006. Institutions and institutional work, in Clegg, S., Hardy, C., Lawrence, T.B., Nord, W.R. (Eds.), Handbook of organization studies, 2nd Edition ed. Sage, London, pp. 215–254.

Lukka, K., Suomala, P. 2014. Relevant interventionist research: balancing three intellectual virtues. Accounting and Business Research, 44, 204–220.

Lukka, K., Vinnari, E. 2014. Domain theory and method theory in management accounting research. Accounting, Auditing & Accountability Journal, 27, 1308–1338.

Lukka, K., Vinnari, E. 2017. Combining actor-network theory with interventionist research: present state and future potential. Accounting, Auditing & Accountability Journal, 30, 720–753.

Lyly-Yrjänäinen, J., Suomala, P., Laine, T., Mitchell, F. 2017. Interventionist management accounting research: theory contributions with societal impact. Routledge.

Major, M. 2007. Activity-based costing and management: a critical review, in Hopper, T., Northcott, D., Scapens, R.W. (Eds.), Issues in management accounting, pp. 155–174.

Makrygiannakis, G., Jack, L. 2016. Understanding management accounting change using strong structuration frameworks. Accounting, Auditing & Accountability Journal, 29, 1234–1258.

Malmi, T., 1997. Towards explaining activity-based costing failure: accounting and control in a decentralized organization. Management Accounting Research, 8, 459–480.

Malmi, T. 2016. Managerialist studies in management accounting: 1990–2014. Management Accounting Research, 31, 31–44.

Merchant, K.A., Van der Stede, W.A. 2007. Management control systems: performance measurement, evaluation and incentives. Pearson Education.

Messner, M. 2016. Does industry matter? How industry context shapes management accounting practice. Management Accounting Research, 31, 103–111.

Miller, P. 2007. Management accounting and sociology, in Chapman, C.S., Hopwood, A.G., Shields, M.D. (Eds.), Handbook of management accounting research. Elsevier, Amsterdam, pp. 285–295.

Mitchell, T., Brynjolfsson, E. 2017. Track how technology is transforming work. Nature, 544(7650), 290–292.

Möller, K., Utz, S., Verbeeten, F. 2020. Digitalization in management accounting and control: an editorial. Journal of Management Control, 31(1–2), 1–8.

Moll, J., Yigitbasioglu, O. 2019. The role of internet-related technologies in shaping the work of accountants: new directions for accounting research. The British Accounting Review, 51(6), 100833.

Munir, R., Baird, K., Perera, S. 2013. Performance measurement system change in an emerging economy bank. Accounting, Auditing & Accountability Journal, 26, 196–233.

Nielsen, S. 2018. Reflections on the applicability of business analytics for management accounting – and future perspectives for the accountant. Journal of Accounting & Organizational Change, 14(2), 167–187.

Nørreklit, H. 2017. A philosophy of management accounting: a pragmatic constructivist approach. Routledge.

Nørreklit, H., Nørreklit, L., Mitchell, F. 2010a. Paradigms and pragmatic constructivism: a reply. Accounting, Auditing & Accountability Journal, 23, 764–773.

Nørreklit, H., Nørreklit, L., Mitchell, F., 2010b. Towards a paradigmatic foundation for accounting practice. Accounting, Auditing & Accountability Journal, 23, 733–758.

Nørreklit, H., Nørreklit, L., Mitchell, F., Bjørnenak, T. 2012. The rise of the balanced scorecard! Relevance regained? Journal of Accounting & Organizational Change, 8, 490–510.

Nørreklit, H., Raffnsøe-Møller, M., Mitchell, F. 2016. A pragmatic constructivist approach to accounting practice and research. Qualitative Research in Accounting & Management, 13(3), 266–277.

Nørreklit, L., Jack, L., Nørreklit, H. 2019. Moving towards digital governance of university scholars: instigating a post-truth university culture. Journal of Management and Governance, 23(4), 869-899.

Nørreklit, L., Nørreklit, H., Israelsen, P., 2006. The validity of management control topoi: towards constructivist pragmatism. Management Accounting Research, 17, 42–71.

Oesterreich, T. D., Teuteberg, F., Bensberg, F., & Buscher, G. 2019. The controlling profession in the digital age: understanding the impact of digitisation on the controller's job roles, skills and competences. International Journal of Accounting Information Systems, 35(C).

Payne, R., 2014. Discussion of 'digitisation, 'Big Data' and the transformation of accounting information' by Alnoor Bhimani and Leslie Willcocks (2014). Accounting and Business Research, 44, 491–495.

Perkhofer, L., Walchshofer, C., Hofer, P. 2020. Does design matter when visualizing Big Data? An empirical study to investigate the effect of visualization type and interaction use. Journal of Management Control, 31, 55–95.

Quattrone, P. 2016. Management accounting goes digital: will the move make it wiser? Management Accounting Research, 31, 118–122.

Rikhardsson, P., Yigitbasioglu, O. 2018. Business intelligence and analytics in management accounting research: status and future focus. International Journal of Accounting Information Systems, 29, 37–58.

Rinta-Kahila, T., Penttinen, E., Salovaara, A., Soliman, W. 2018. Consequences of discontinuing knowledge work automation-surfacing of deskilling effects and methods of recovery, in Proceedings of the 51st Hawaii International Conference on System Sciences. 5244-5253.

Scapens, R.W. 2014. My final editorial. Management Accounting Research, 25, 245–250.

Scapens, R., Jazayeri, M. 2003. ERP systems and management accounting change: opportunities or impacts? European Accounting Review, 12, 201233.

Skitka, L.J., Mosier, K., Burdick, M.D. 2000. Accountability and automation bias. International Journal of Human-Computer Studies, 4, 701–717.

Stormi, K., Lindholm, A., Laine, T., Korhonen, T. 2019. RFM customer analysis for product-oriented services and service business development: an interventionist case study of two machinery manufacturers. Journal of Management and Governance, 24(3), 623–653.

Suomala, P., Lyly-Yrjänäinen, J., Lukka, K. 2014. Battlefield around interventions: a reflective analysis of conducting interventionist research in management accounting. Management Accounting Research, 25, 304–314.

Sutton, S.G., Arnold, V., Holt, M. 2018. How much automation is too much? Keeping the human relevant in knowledge work. Journal of Emerging Technologies in Accounting, 15, 15–25.

Van de Ven, A.H., Johnson, P.E. 2006. Knowledge for theory and practice. Academy of Management Review, 31, 802–821.

Van der Stede, W.A. 2016. Management accounting in context: Industry, regulation and informatics. Management Accounting Research, 31, 100–102.

Vasarhelyi, M.A., Kogan, A., Tuttle, B.M. 2015. Big data in accounting: an overview. Accounting Horizons, 29, 381–396.

Viale, T., Gendron, Y., Suddaby, R. 2017. From “mad men” to “math men”: the rise of expertise in digital measurement and the shaping of online consumer freedom. Accounting, Auditing & Accountability Journal, 30, 270–305.

Vitale, G., Cupertino, S., Riccaboni, A. 2020. Big data and management control systems change: the case of an agricultural SME. Journal of Management Control, 31, 123–152.

Warren Jr., J.D., Moffitt, K.C., Byrnes, P. 2015. How Big Data will change accounting. Accounting Horizons, 29, 397–407.

Woods, D.D. 1996. Decomposing automation: apparent simplicity, real complexity. In Parasuraman, R.; Mouloua, M. (Eds.), Automation and Human Performance: Theory and Applications, Erlbaum, pp. 3-17.