Competing on Digitalization Transformation:
The Relationship Between Enterprise Resource Planning, Management Control Systems, and Dynamic Capabilities

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Abstract

This thesis examines the impact of enterprise resource planning (ERP) on the use of management control systems (MCS) in developing dynamic capabilities (DC) in China's modern manufacturers. Over the recent ten years, China has been reforming its economic structure through the digital transformation that promotes productivity, expands the market size and customer bases, and stimulates economic growth. Existing accounting-IT studies have two major gaps that inhibit us from understanding the impact of digital transformation. First, they do not examine the strategic impact of digitalization-based accounting, but existing accounting research has recognized the importance of studying the strategic impact of accounting (e.g., Henri 2006; Marginson 2002; Mundy 2010; Pešalj *et al.* 2018). Second, they focus on outdated technologies, but the digital transformation that aims to source competitive advantage forces Chinese manufacturers to reconsider using new digital technologies (e.g., Clouding, Big data, and advanced ERP) and abandon the old ways.

This thesis fulfils the gaps by addressing the three most critical frontier MCS research issues, namely, the strategic role of MCS at the capability level (e.g., Henri 2006), the effective MCS configurations (e.g., Grabner and Moers 2013; Sandelin 2008), and the MCS complementarity (e.g., Adler and Chen 2011; Chenhall and Moers 2015). Subsequently, I bring these three issues into the discussion of how manufacturers can steer the digital transformation by making an ERP upgrade in three core business contexts, respectively (i.e., customer relationship management, material resource management, and integration of production and research and design).

An in-depth single case study is undertaken to explore the MCS change after an ERP upgrade in three core contexts of DC that academics consider necessary to theorize and analyze the digital transformation process: three building block routines of DC (i.e., sensing, seizing, and reconfiguring routines), resource reconfiguration, and resource orchestration. Further, the thesis adopts three theories to seek the generative process,

forms, and relations of the MCS changes, and the relation between MCS changes, ERP and DC. Drawing on the organizational routine theory, I reveal that the MCS changes that improve the three routines are produced through enhancing information connection at the artifact aspect, action pattern abstraction at the ostensive aspect, and bottom penetration at the performative aspect. Adopting the notion of studying MCS as a package, I find that the MCS changes that support resource reconfiguration actions lie within three forms of MCS configurations producing varying levels of visibility, recognizability, and controllability of organizational actions and resources. Finally, guided by levers of control, I discover that the MCS changes involve shifting complementary relations between different MCS practices, and senior management involvement determines the leveraging effect of the shifting complementary relation on resource orchestration.

This thesis empirically contributes to the critical understanding of how information technology is "simultaneously a challenge and a resource for management control" (Dechow *et al.* 2006, p. 625) by tracing the generative process, forms, and relations of the MCS changes in the context of growing demand in the ERP upgrade in China. Also, this thesis theoretically contributes to the theory of organizational routine, the notion of studying MCS as a package, and the theory of levers of control by further extracting the constructs involved within the routine-in-use in the accounting context, refining how the MCS configuration forms may vary, and identifying the shifting nature of the complementary relations between the control levers. Finally, the findings of this thesis provide practical implications of how accounting practices can support mobilizing organizational resources to materialize specific DCs effectively and benefit from the digital transformation.

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Acronym list

IT	Information technology	IT covers any form of technology, any equipment or techniques used by a company, institution, or any other organization that handles information. It incorporates computing, telecommunication technologies and includes consumer electronics and broadcasting as it is getting more and more digitized (Grauer 2001, p. 7473).
ICT	Information and communications technology	ICTs are not limited to access to information or computer technology, as suggested by the conventional discussion of "haves" and "have-nots". ICT shapes the access of an individual, household, company or country to information, people, services, and technology. ICTs shape access, both electronically mediated and unmediated, to a wide array of social and economic resources (Dutton 2001).
IS	Information systems	An IS is complex, made up of hardware, software, and other parts, some with their own unique communication language. Each part is constructed differently according to certain principles, including digital principles (e.g., the relationship between information and data), digital representation of information, calculation of binary code, and conversion between decimal and binary code (Wang 2013, pp. 97-68).
ERP	Enterprise resources planning	ERP is the generic name for software systems that integrate multiple data sources and organizational processes in a unified system. These applications are used to store, retrieve, and share information on any aspect of the sales and organizational process in real-time. This includes standard metrics like production, deliveries, machine failures, orders, and stocks and broader metrics on human resources and finance (Bloom *et al.* 2014, p. 2860).
MA	Management accounting	MA is the process of identification, measurement, accumulation, analysis, preparation, interpretation of communication of information used by management to plan, evaluate and control within an entity and to assure appropriate use of accountability for its

		resources (Eaton 2005).
MCS	Management control systems	An MCS is the formal, information-based routine and procedures used by managers to maintain or alter organizational action patterns (Simons 1994).
DC	Dynamic capability	DC refers to the ability to integrate, build, and reconfigure internal and external resource, capabilities, and competencies to address rapidly changing environments (e.g. Eisenhardt and Martin 2000).
RR	Resource reconfiguration	RR enables companies to create a superior performance through addition, deletion, or movement of resources (Karim 2006; Karim and Mitchell 2004), promoting the distinctive accumulation of organizational resource bases (Capron and Mitchell 2009; Das and Teng 2000; Hennart and Park 1993; Kale and Singh 2007; Karim and Mitchell 2000), making incremental change within existing organizational principles[i] (Girod and Whittington 2017).
RO	Resource orchestration	RO does not merely consist of resources-possessing routines (Cui *et al.* 2017; Priem and Butler 2001; Sirmon *et al.* 2011), but involves the structuring routine, bundling routine, and leveraging routine (e.g. Helfat *et al.* 2007; Sirmon *et al.* 2007; Sirmon *et al.* 2011). RO promotes strict coordination and synchronization of research and development and production actions (Carnes *et al.* 2017; Chirico *et al.* 2011; Ketchen Jr *et al.* 2014; Nambisan and Sawhney 2011; Schriber and Löwstedt 2018).
LOC	Levers of controls	LOC claims that the power of MCS techniques to control business strategy, it is argued, does not lie in how each is used individually, but rather in how they work together, how they complement each other, and how they achieve balance (Kruis *et al.* 2016).
SME	Small-medium sized enterprises	SMEs are non-subsidiary, independent companies that employ fewer than a given number of employees.
R&D	Research and development	R&D is the process by which a company works to obtain new knowledge that it might use to create new technology, products, services, or systems that it will either use or sell.
NPD	New product development	New product development aims to update the firm's

[i] The author claim that "Restructurings involve fundamental change in organizational principles and are typically irregular" (p. 1121).

		product portfolio (Helfat and Raubitschek 2000), which has become a central dimension in many companies' strategies (Brown and Eisenhardt 1995; Gupta and Wilemon 1990).
BPR	Business process re-engineering	BPR is a business management strategy that focuses on the analysis and design of workflows and business processes within an organization (Davenport 1992).
ANT	Actor-network theory	ANT is a theoretical and methodological approach to social theory where everything in the social and natural worlds exists in constantly shifting networks of relationships (Latour 1996).

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Chapter 1. Introduction

This thesis investigates how enterprise resource planning (ERP) and management control systems (MCS) work together to develop dynamic capabilities (DC). To better understand this accounting digitalization practice, I focus on the impact of post-upgrading ERP on MCS changes within the context of China's rapid digitalization-based transformation. In the context of a change from an old ERP to a new ERP in a Chinese company, the ERP-based MCS changes are explored in three core business actions and processes: first, customer relationship management (CRM), second, material resource-related actions and processes; and third, new product development practices (NPD).

This first section presents the research background and identifies the research gap. Research objectives and novelties are then described, as are the theories and methodology. The main findings and contributions are discussed, which provides the structure of the thesis.

1.1 Research background: China's rapid digitalization-based transformation and the digitalization of accounting practices

Digitalization is a recognized area with opportunities for future research in management accounting[1] (e.g., Bromwich and Scapens 2016). Digitalization refers to the increasing use of digital technologies to connect people, systems, companies, products, and services (Hsu 2007). More than simply transforming existing data into digital data, digitalization involves the capability of digital technology to collect data, establish trends and make better business decisions (e.g., Björkdahl 2020; Legner *et al.* 2017; Rachinger *et al.* 2019; Ringenson *et al.* 2018). Digitalization is a trend that currently offers many new opportunities to existing companies (Coreynen *et al.* 2017; Verhoef *et al.* 2021).

[1] The other two are industry and regulation.

However, the digitalization process challenges accounting scholars to understand and theorize the accounting changes that are essential in accounting research (Quattrone 2016), however, precisely *how* digitalization affects accounting remains unclear (Granlund 2011; Quattrone 2016). Digitalization is expected to affect accounting in new ways, including the acquisition, collation, and use of new types of information (Arnaboldi *et al.* 2017), the reconfiguration of power relations (Scott and Orlikowski 2012), and the introduction of novel decision-making practices (Quattrone 2016, 2017). Conversely, digitalization is associated with significant changes related to socio-material structures (e.g., Gaskin *et al.* 2014; Wagner *et al.* 2011). According to the Boston Consulting Group (BCG) analysis (see Diagram 1), nearly 70% of companies have failed in their digital transformation (Forth *et al.* 2020). In other words, digitalization-based accounting change may be risky (e.g., Dechow *et al.* 2006), therefore, more research on the impact of digitalization on accounting processes is needed, given that technology is a dynamic organism (e.g., Bhimani and Willcocks 2014; Prasad and Green 2015; Quattrone 2016), and its impact on accounting change is also dynamic (Knudsen 2020).

[Insert Diagram 1 here]

This thesis focuses on accounting digitalization in the context of China. China's digitalization trend has been surging in recent years, outperforming most other countries. Over the past eight years, China's government has advocated a rapid digitalization-based transformation in the manufacturing industry in order to respond to rapid environmental and global changes. Liu *et al.* (2011, p. 1730) argue that digital transformation is "an organizational transformation that integrates digital technologies and business processes in a digital economy." This rapid digitalization-based transformation is expected to support Chinese manufacturers in boosting productivity and innovation, and (necessarily) entailing a strategy reconfiguration and/or profound changes in the business conduct (e.g., He *et al.* 2020; Warner and Wäger 2019).

Indeed, digital transformation leads to accounting transformation[2] (e.g., Troshani *et al.* 2019). Although China's rapid digitalization-based transformation started to increase in pace some years ago, accounting practices have already been digitally transformed to some extent, especially the ERP-based MCS practices.

The Chinese government has initiated a series of accounting changes to respond to the rapid digitalization-based transformation. In 2014, China's Minister of Finance (MOF) issued 'The Guiding Opinions of the Ministry of Finance on Comprehensively Promoting the Construction of Management Accounting Systems'. Subsequently, in 2016 and 2017, the MOF issued 'A Basic Guide to Management Accounting' and 'Management Accounting Application Guidelines No. 802-Management Accounting Information System.' However, most Chinese companies do not yet have a stable digitalization foundation (e.g., Nikookar *et al.* 2010; Romero *et al.* 2010). The digitalization of accounting brings about both opportunities and challenges to most Chinese manufacturers, and, due to the emerging nature of the transformation, it remains unclear how companies will develop and/or benefit from the digitalization of accounting.

According to Quattrone (2016), exploring the digitalization-based MCS helps to understand how MCS can gain the central stage in the organizational arena, within the context of rapid digitalization-based transformation. In addition, intensive research and case studies are being encouraged by the MOF to explore digitalization-based MCS practices in Chinese companies.

This thesis focuses on ERP-based MCS in the modern digitalization age. In terms of business digitalization solutions, ERP remains one of the most prevalent solutions for enhancing productivity and increasing the efficiency of a workforce. ERP provides data and functions, automating existing business processes, promoting decision-making and control, and utilizing digital transformation to enhance the way products and services

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[2] Troshani et al. (2019) demonstrate that the emergence of digital technologies is transforming corporate reporting infrastructure and communication.

are delivered to customers (e.g., Baiyere *et al.* 2020; Hess *et al.* 2016; Westerman and Bonnet 2015; Westerman *et al.* 2014). Furthermore, ERP has a major impact on digital transformation. It has the potential to bring about revolutionary changes in the various processes of modern business (e.g., Moh'd Anwer 2019; Motwani *et al.* 2002), however, there remains a considerable research gap concerning the ERP-based MCS. The next subsection discusses the research gap that emerges from existing MCS-ERP literature.

1.2 Research gap: an emergent issue of accounting in China's rapid digitalization-based transformation

Only a small number of prior studies relate to the MCS-ERP relationship, but they have limitations (e.g., Chapman and Kihn 2009; Dechow and Mouritsen 2005; Granlund and Malmi 2002; Hyvönen *et al.* 2008; Wagner *et al.* 2011). There are two primary MCS-ERP research streams.[3] The earliest stream of research focuses on the relationship between ERP and MCS (Granlund and Malmi 2002; Scapens and Jazayeri 2003), while the second stream follows and extends the first stream, investigating how ERP and MCS work together as a system (Dechow and Mouritsen 2005; Quattrone and Hopper 2005; Wagner *et al.* 2011).

However, Granlund (2011, p. 6) states that, "[the extant research streams] can be considered to have only opened the discussion" (Granlund 2011, p. 6). The existing MCS-ERP literature does not discuss ERP in concrete terms (Granlund 2011).[4] Later, Wagner *et al.* (2011) investigate the working accounting information system in concrete terms by examining how two new modules were added to manage grant funds so as to meet the unique needs of higher education.

The existing literature has two major limitations. First, it does not focus on the strategic impact of ERP-based MCS, while most MCS studies have recognized the impact of

[3] Note: the literature and their limitations will be discussed and analyzed more in detail later in Section 1.3 and in the literature review section of each empirical chapter.

[4] The author claims: "A shortcoming… is that it talks about IT in quite general terms, like simply calling the technology ERPS. We seem to learn very little about the technology in terms of how budgeting or costing is actually carried out on this platform; what it "looks like" and how it affects managerial work in concrete terms" (p. 11).

MCS use on strategic management (e.g., Henri 2006; Marginson 2002; Mundy 2010; Pešalj *et al.* 2018). Indeed, the literature is too narrow by focusing on an accounting perspective, and has produced an overview of the ERP-based MCS practices without addressing any specific strategic issues. Second, the existing literature is insufficient to explain the impact of the ongoing ERP changes on MCS (Wagner *et al.* 2011). At the same time, new digital techniques have been emerging (e.g., Majchrzak *et al.* 2016; Nambisan *et al.* 2019), especially the post-upgrading of ERP (e.g., Barth and Koch 2019; Elragal 2014; Elragal and Haddara 2012; Esteves 2014). The existing literature remains focused on outdated ERP technologies only; thus the literature has not yet captured the emerging technologies.

Therefore, a research gap exists: little is known about how the post-upgrading of ERP and MCS work together to facilitate strategic management. This gap becomes especially interesting in the context of China's rapid digitalization-based transformation. Most Chinese companies have considered upgrading ERP to digitally transform their accounting and operational systems (e.g., Bossert and Laartz 2017; Choi *et al.* 2013; Hartley and Sawaya 2019; Malaurent and Avison 2015; Sun *et al.* 2015; Westerman *et al.* 2014), however, most Chinese companies face a markedly higher ERP failure rate than Western countries (e.g., Ge and Voß 2009; Zhang *et al.* 2005). In addition, the digitalization-based fast transformation is a strategic issue concerning the creation of competitive advantages, but most experts believe that the digital transformation of Chinese companies is still at the stage of "crossing the river by feeling the stones".[5]

The process of digitalization largely occurs "behind closed doors". Indeed, knowledge of any digitalization transformation is mainly hidden on the consultant vendors' side. Although consultant vendors are knowledgeable in digitalizing legacy systems and building data-driven organizations, their experience is not sufficiently transformed or understood from organizational, strategic, and accounting perspectives.

[5] For example, https://3w.huanqiu.com/a/c36dc8/3ymg0J0xog8?p=3&agt=4

1.3 Resources objectives: MCS changes, dynamic capabilities (DC), resource reconfiguration (RR), and resource orchestration (RO)

This study bridges the research gap by meeting three research objectives that will be addressed in each of the three empirical chapters. These objectives focus on three critical issues concerning accounting digitalization: first, improving customer relationship management (CRM); second, facilitating resource optimization; and last, promoting new product development (NPD) practices.

The first research objective investigates the impact of the post-upgrading of ERP on CRM changes and discovers possible ways of using ERP-based MCS to develop three DC routines (i.e., sensing routine, seizing routine, and reconfiguring routine). The second research objective investigates how the post-upgrading of ERP impacts MCS configurations and reconfigurations, and how the ERP-based MCS configurations and reconfigurations enable resource reconfiguration (RR). The third objective explores how the post-upgrading of ERP leverages the sophisticated use of MCS in NPD practices and traces how the leveraging effect enables resource orchestration (RO). The following three subsections are used to explain and justify them, respectively.

1.3.1 The post-upgrading of ERP, MCS changes, and three different DC routines

The first research objective investigates the impact of the post-upgrading of ERP on CRM practice changes and discusses possible ways of using ERP-based MCS to develop three different DC routines (i.e., sensing routine, seizing routine, and reconfiguring routine). DC consists of three specific routines: first, sensing routine to identify and evaluate opportunities and risks; second, seizing routine to mobilize resources to address opportunities and to capture value from doing so; and third, reconfiguring routine to continue renewing the resource base (e.g., Leih *et al.* 2015 ; Teece 2007). Existing MCS-ERP research does not explain the relationship between MCS, ERP, and DC routines, but DC concepts are important in studying operational and strategic issues (e.g., changes of organizational resources and routines, and developing products and services, sourcing of competitive advantage). Based on studying the relationship between ERP, MCS, and three DC routines, this research objective is explained and justified in three ways, respectively.

The first research objective helps to explain how ERP-based MCS helps a company develops three concrete strategic (DC) routines to respond to rapid technological and market changes (e.g., Eisenhardt and Martin 2000; Helfat *et al.* 2007; Stefano *et al.* 2014). The digitalization strategy challenges the ERP's CRM module (as core ERP-based MCS practices) to cope with increasingly digitalized businesses and complex customer needs (e.g., Lai *et al.* 2016; Li 2011; Li *et al.* 2017b; Nikookar *et al.* 2010; Romero *et al.* 2010; Zhu *et al.* 2010).

Motivated by the fact that most Chinese companies face a considerably higher ERP failure rate than Western countries (e.g., Ge and Voß 2009; Zhang *et al.* 2005), this chapter focuses on the impact of post-upgrading ERP on CRM practices and changes in Chinese manufacturing companies. This knowledge enhances our understanding of how ERP-based MCS enables Chinese companies to cope with the rapid change in customers, technologies, and competition encountered during the rapid digitalization reform process.

Additionally, the first research objective offers further understandings of the strategic impact of ERP-based MCS, exploring how it creates competitive advantages through three DC routines. Studying the strategic impact of MCS is a research tradition of MCS in order to secure the central role of MCS in the organizational arena (e.g., Henri 2006; Marginson 2002; Otley 1980; Simons 1994). The existing MCS-ERP research offers understandings relevant to broader organizational issues, [6] however, as their frameworks are primarily based on institutional and socio-material concepts, the extant knowledge merely forms the basis for, but is insufficient to, understand the strategic issues.

[6] The issues include the human motivations that drive the change to occur (Dechow and Mouritsen 2005; Granlund and Malmi 2002; Quattrone and Hopper 2005), the process of the change (Dechow and Mouritsen 2005; Granlund and Malmi 2002; Hyvönen et al. 2008; Quattrone 2016; Scapens and Jazayeri 2003), and the general performance effect of the change (Chapman and Kihn 2009; Kallunki et al. 2011; Teittinen et al. 2013; Xiao et al. 2011).

DC concepts have been widely used in the business strategy literature (e.g., Eisenhardt and Martin 2000; Winter 2003; Zollo and Winter 2002) and IT literature (Bernroider *et al.* 2014; Chen *et al.* 2008; Mikalef and Pateli 2017; Sher and Lee 2004). DC concepts are believed to be effective at revealing the generative process through which competitive advantages are produced in dynamic conditions (e.g., rapid transformation). Drawing on DC helps to explore the strategic impact of ERP-based MCS to a significant depth at the strategic level (Wade and Hulland 2004). The three DC routines (i.e., sensing routine, seizing routine, and reconfiguring routine) help to capture the strategic impact of ERP-based MCS and trace how ERP-based MCS transforms the potential for creating competitive advantages.

Third, the first research objective helps to understand the micro-foundations of MCS changes in the digitalization age. The accounting change is understood in multiple ways.[7] DC gives an alternative view of the change (i.e., the micro-foundation of the change). Understanding a set of actions is an effective way to study the micro-foundation of organizational change (Abell *et al.* 2008; Cohen and Bacdayan 1994; Greve 2008; Lazaric and Denis 2005; Pentland *et al.* 2012). The micro-foundation helps to understand what the accounting change actually is (Becker *et al.* 2005), thus contributing to theoretical debate and advancement (Camerer *et al.* 2005; Jennings and Greenwood 2003; Kahneman and Tversky 2013; Lawrence *et al.* 2009; Powell and Colyvas 2008). DC is interpreted as consisting of a set of actions that must be collective, repeatable, or patterned, and oriented to relatively specific objectives (Winter 2003). Therefore, studying the MCS changes in relation to DC helps capture the ERP-based MCS changes at the micro-foundation level to further reveal and theorize accounting changes in the ERP context (Bhimani and Willcocks 2014).

1.3.2 <u>The post-upgrading of ERP, MCS configurations and reconfigurations, and RR</u>

The second research objective investigates how the post-upgrading of ERP impacts

[7] For example, changing, non-linear and linear, revolutionary and evolutionary, social-material, and phenomenon and non-phenomenon (e.g., Bhimani 1996; Burns and Scapens 2000; Burns and Vaivio 2001; Wagner et al. 2011).

MCS configurations and reconfigurations and how the ERP-based MCS configurations and reconfigurations enable RR. RR is an important mechanism in developing the process of DC (Eisenhardt and Martin 2000), as it describes how companies exact value from optimizing an existing resource base without radical organizational changes (e.g., Girod and Whittington 2017). The existing MCS-ERP literature does not investigate how MCS and ERP continue to create a unique and distinctive resource base; instead, how to create a unique and distinctive resource base has been recognized as critical to understanding MCS effectiveness (e.g., Bisbe and Otley 2004; Gerdin *et al.* 2019; Henri 2006), IT performance (Benitez-Amado and Walczuch 2012; Vanpoucke *et al.* 2017; Wang *et al.* 2012), and operational improvement (Hwang and Min 2015; Liu *et al.* 2016). This research objective, based on studying the relationship between ERP, MCS, and RR, is explained and justified in three ways.

The second research objective helps, first, to address how ERP-based MCS practices promote resource optimization[8] that is critical to China's rapid digitalization-based transformation (e.g., Heng 2018; Kang and Feng 2018). The rapidly increasing trend of digitalizing business encourages companies to create novel RR in order to optimize their resources leading to enhanced value (Amit and Han 2017; Hitt *et al.* 2011). ERP-based MCS may have a central role in achieving resource optimization because ERP leads to the integration and reconfiguration of multiple control loci and the diffusion of power that are integral in resource optimization (e.g., Quattrone 2016; Quattrone and Hopper 2005). Nevertheless, little is known about how ERP-based MCS affects RR generally, or specifically. This chapter explores the possible ways that ERP-based MCS could prompt digitalizing resource optimization in the manufacturing industry.

Second, the second research objective aims to understand the ERP-based MCS configuration and reconfiguration issues. China's rapid digitalization-based transformation leads to increasingly dynamic environments, causing MCS to shift from

[8] In the reform, resource optimization involves a set of organizational goals to seek an optimal way to allocate resources and to improve the quality and quantity of economic growth, including "cut overcapacity", "de-stock", "de-leverage", "reduce costs", and "shore up weak spots".

a relatively simple form of controls[9] that support strategy implementation to a more sophisticated form[10] of control configurations that support strategy formulation (Chenhall and Moers 2015; Marginson 2002; Pisano 2017; Schilke 2014; Simons 1994).

Existing MCS-ERP studies reveal that the deeper interconnectedness of digital technologies (e.g., ERP), accounting, and context makes the complex form of control configurations possible (e.g., Dechow and Mouritsen 2005; Quattrone and Hopper 2005; Wagner *et al.* 2011). However, existing MCS-ERP studies have not sufficiently addressed how the ERP-based MCS develops and evolves to adapt to strategic and environmental changes (e.g., Kruis *et al.* 2016; Mundy 2010; Pešalj *et al.* 2018; Speklé *et al.* 2017). RR is a concrete case that essentially requires digital technologies (Coreynen *et al.* 2017) to develop a complex form of controls (Eisenhardt and Martin 2000; Teece 2007; Teece *et al.* 1997). This research objective offers new ways to understanding how a set of MCS practices configure and reconfigure in digital ways to develop RR.

Third, the second research objective offers new insights into accounting changes by addressing how the MCS configuration forms may vary in ERP. Wagner et al. (2011, p. 181) demonstrate that digitalization-based accounting changes are dependent on "the particular entanglement of users and technology." Extending the studies of Dechow and Mouritsen's (2005) and Wagner et al.'s (2011), I further specify this entanglement (or interconnectedness).

Given the importance of context in studying MCS (Dechow and Mouritsen 2005; Otley 1980; Wagner *et al.* 2011), I focus on the RR context that is prevalent in recent strategic studies. RR explores how a company modifies its resource base to renew its competitive advantage while maintaining stability in dynamic environments (Anand and Khanna 2000; Capron and Mitchell 2009; Das and Teng 2000; Dussauge *et al.* 2000; Kale and Singh 2007). In this way, this chapter offers new understandings of how the

[9] For example, cybernetic controls.

[10] That is, more complex, open, and integrated controls.

entanglement occurs within a much more dynamic context and how the users and technology become entangled without inducing radical changes to the existing resource base.

1.3.3 *The post-upgrading of ERP, the sophisticated use of MCS in NPD practices, and RO*

The third objective explores how the post-upgrading of ERP leverages the sophisticated use of MCS in NPD practices and traces how the leveraging effect enables resource orchestration (RO). RO describes how companies are pushing the integration of R&D and production functions under complicated spatial-temporal conditions (Cui and Pan 2015; Schriber and Löwstedt 2018). RO addresses NPD issues about how scarce resources are structured, bundled, and leveraged properly for a specific market (e.g., Cooper and Edgett 2003; Repenning *et al.* 2001; Sirmon *et al.* 2007; Sirmon *et al.* 2011; Yu *et al.* 2010).

The existing MCS-ERP literature does not focus on RO and NPD issues, however the MCS literature has recognized the importance of studying MCS to address NPD issues, to ensure greater alignment, coordination, and direction for a particular use (e.g., Davila *et al.* 2009; Davila 2000; Henri 2006). Next, the research objective that is based on studying the relationship between ERP, MCS, and RO, is explained and justified in three ways, as follows.

First, the third research objective accords with the need to digitalize accounting to integrate R&D and production necessary for developing and delivering new products. Over recent years, Chinese manufacturers have been digitalizing efficiency and innovation, enabling them to compete on a global scale. Indeed, the integration of production (efficiency) and R&D (innovation) is considered critical for companies to retain competitiveness (Cheng *et al.* 2015; Eng and Ozdemir 2014). RO also relies heavily on the use of digital technologies in order to promote effective coordination and synchronization in conjunction with other managerial techniques (e.g., accounting) (e.g., Cui and Pan 2015; Cui *et al.* 2017; Grover and Kohli 2013; Hess *et al.* 2016; Liu *et al.* 2016; Yeow *et al.* 2018; Zhou *et al.* 2017).

Conversely, reportedly, digitalization-based accounting practices have not benefited many Chinese companies' RO due to inappropriate ERP module configuration and ineffective implementation (Avison and Malaurent 2007; Li *et al.* 2017b; Luo and Strong 2004; Wei *et al.* 2005; Xue *et al.* 2005).[11] This research objective bridges a knowledge gap regarding how accounting and digital technologies are involved in the integration of R&D and production functions that is critical to rapid digitalization-based transformation.

Second, the third research objective offers understandings of the sophisticated use of MCS in the context of China's rapid digitalization-based transformation. Existing MCS-ERP studies endeavor to find out how ERP enables MCS change and more sophisticated[12] use of MCS (e.g., Dechow and Mouritsen 2005; Granlund and Malmi 2002; Quattrone and Hopper 2005; Scapens and Jazayeri 2003; Wagner *et al.* 2011). These studies demonstrate that ERP adoption results in minor MCS changes.

However, existing MCS-ERP studies may not be sufficient to explain ERP-based MCS for RO that characterizes rapid digitalization-based transformation. Within RO, companies face dramatic environmental changes because digitalization heavily relies on digital means to stimulate operational efficiency and innovation. According to contingency theory, RO may require the sophisticated use of MCS (e.g., Chenhall 2006; Otley 1980). In this sense, this research objective reveals alternative aspects of MCS

[11] The ERP typically encompasses all functions including finance, sales, CRM, accounting, manufacturing, payroll, etc. For example, Li et al. (2017) indicate that 86 percent of the sample company had adopted more than one ERP modules, with four modules being the most prevalent choices (52 percent). When examining the types of modules being implemented, financial management (83 percent), purchasing and supply management (76 percent), inventory and warehousing (70 percent), sales (65 percent), and production (64 percent) were the distinctive top five.

[12] According to Abdel-Kader and Luther (2008, p. 3), the sophisticated use of MCS refers to the capability of an MCS "to provide a broad spectrum of information relevant for planning, controlling, and decision-making all in the aim of creating or enhancing value." Presumably, non-sophisticated use of MCS may embody weak financial control, insufficient information for planning and control, unable to reduce waste in organizational resources, feeble to create value through effective resource use.

changes, deepening the understandings of the sophisticated use of MCS via ERP.

Third, the third research objective helps to understand the nature of accounting change in the digitalization age. Existing studies have emphasized that digitalization-based accounting change is non-linear (e.g., Dechow and Mouritsen 2005; Wagner *et al.* 2011). The change may no longer be a systematic endeavor that proceeds towards a well-specified, explicit objective according to a pre-set scheme, ordered stages, and an agreed procedure (Burns and Vaivio 2001). However, although Burns and Vaivio (2001, p. 397) underline the theoretical pluralism in studying the non-linear MA change, the institutional view still dominates.[13]

Based on the resource-based view, RO offers theoretical pluralism because “institutional theory and strategic management were initially on separate trajectories with little overlap” (Zhao *et al.* 2017, p. 96).[14] RO is more concerned with how to effectively identify and accumulate unique resources and capabilities, creating value through continuous resource reconfiguration, and cultivating unique market positions (e.g., Chadwick *et al.* 2015; Chirico *et al.* 2011; Sirmon *et al.* 2011). By tracing the non-linear MCS change for RO, this objective produces knowledge about how accounting changes occur in digital ways to enable continuous resource optimization.

Fulfilling each of the three research objectives describes how companies can use ERP-based MCS practices to continue sourcing the competitive advantages in dynamic conditions, in order to remain relevant in the emergent digital economy.

1.4 Theories

This thesis develops three self-contained empirical chapters to meet the research objectives. Each chapter has adopted a theory. The first empirical chapter (Chapter 3)

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[13] From the institutional perspective, ERP-related accounting changes are usually explained in relation to organizational passivity and resistance, but not relevant to address strategic impacts.

[14] The authors claim that “strategy scholars argued that companies obtain a sustainable competitive advantage by cultivating unique market positions and developing resources and capabilities that are valuable, rare, and inimitable by rivals… institutional theory… focused on legitimacy as the key driver affecting organizational resource acquisition, survival, and performance (typically conceptualized as “effectiveness”).

adopts Feldman and Pentland's (2003) theory of organizational routine (TOOR) so as to meet the first research objective. The second empirical chapter (Chapter 4) adopts Malmi and Brown's (2008) framework of studying MCS as a package in order to meet the second research objective. The third empirical chapter (Chapter 5) adopts Simons' (1994) theory of levers of control (LOC) to meet the third research objective.

In the first empirical chapter (Chapter 3), I adopt three concepts of TOOR to investigate the micro-foundation of the MCS change and its impact on DC in three ways: first, the ostensive aspect of routine (i.e., the abstract or schematic form of a routine); second, the performative aspect of routine (i.e., concrete or specific actions by specific people in specific places and times); and third, artifacts (i.e., the means to continue the routine, including written rules and digitally-codified procedures, software and computers, and general physical settings).

These represent the three core components of enacting a routine (e.g., a budgeting routine), and then I adopt them, as both MCS and DC are organizational routines (e.g., Feldman and Pentland 2003; Simons 1994; Teece *et al.* 1997). The theory also theorizes the role of ERP as an artifact in organizational routine to help actors carry out real routines. Finally, the movement from the ostensive aspect to the performative aspect can indeed be interpreted as MCS practices, such as "guiding, accounting, and referring" organizational actions (Feldman and Pentland 2003, p. 106). Such concepts offer a starting point for enhancing our understanding of the relationship between ERP, MCS, and DC. In particular, they offer an insight into how ERP and MCS work together to develop DC.

In the second empirical chapter (Chapter 4), I draw on Malmi and Brown's (2008) framework of studying MCS as a package, focusing on how various MCS techniques are (re)configured by ERP in the RR context. Malmi and Brown's (2008) framework identifies five main MCS techniques: planning controls, cybernetic controls, administrative controls, cultural controls, and incentive and compensation controls. These MCS techniques suggest that each MCS practice has both decision-support and control functions, enabling me to clarify a real single MCS practice in the RR context.

Second, they suggest an examination of how single MCS practices combine with others to reconfigure when necessary in order to solve particular control problems and reach specific RR goals. This concept then allows me to identify the need for MCS modification or changes and to capture modified forms of MCS in the RR context, meeting the aim of the chapter, to examine the MCS reconfiguration for resource reconfiguration and capture how the change or modification varies.

In the third empirical chapter (Chapter 5), I adopt Simons' (1994) LOC framework (i.e., levers of control) to examine the sophisticated use of MCS (via ERP) in the RO context. I apply two concepts of LOC: namely, the diagnostic lever (i.e., by the use of critical performance measures) and the interactive lever (i.e., by identifying strategic uncertainties). These two concepts link the use of MCS between the operational level (i.e., the diagnostic lever) and the strategic level (i.e., the interactive lever).

These concepts are used for three reasons. First, RO seems to be associated with the use of MCS to achieve innovation and operational efficiency simultaneously. LOC leads to an examination of the sophisticated use of MCS practices in innovation and strategic renewal on the one hand, and predictable operational goal achievement (e.g., Arjaliès and Mundy 2013; Kruis *et al.* 2016; March 1991; Raisch and Birkinshaw 2008) on the other. Second, RO might not rely on the use of single MCS techniques but depend on how they complement each other in addressing complexities (e.g., complementing the diagnostic lever and interactive lever). Grabner and Moers (2013, p. 412) state that, "MC practices are complements when the benefits of one MC practice increase with the use of (some) other MC practice (and vice versa)".[15] LOC then leads to an examination of the complementary use of single MCS techniques, other than the isolated use of MCS techniques. Third, in RO, the performance impact of any single MCS technique is not isolated. LOC suggests an assessment of the interdependent impact of MCS techniques on RO. LOC helps to capture the mobilization of accounting between operational and strategic levels and reveals the essential and distinguishing

[15] The authors make a note that: "Strictly speaking, in complementarity theory, complements are defined by a non-negative cross-partial rather than a strictly positive one (p. 412)".

attributes of accounting changes in the digitalization age.

1.5 Methodology

Based on these conceptual frameworks, I conduct a qualitative case study at SunPlants. SunPlants is a medium-sized Chinese discrete manufacturer providing complete equipment for the global petroleum industry. SunPlants experienced a radical ERP upgrade in 2013, which has created significant benefits to the CRM, production efficiency, and R&D, building a solid foundation for its digitalization transformation. Over the last 10 years, SunPlants has been in a leading position in its competitive market. The SAP-based MCS has helped SunPlants secure this position over the last seven years, to some degree. The company was granted an award as the national pioneer of digitalization transformation in 2019 and is unique in having only rare experiences of digitalization failure.

This case study sourced data from 67 interviews with senior managers, middle managers, and employees of SunPlants and its software vendor's engineers. Approximately 300 pages of internal documents of the case company were sourced, which include the SAP project investigation documents, digitalization progression reports, IPO prospectus, organizational profiles, and online sources. The interviews took place between January 2018 and August 2019 (see Diagram 3 Timeframe), and the internal documents were provided by the interviewees.

This case study, corroborated by the three sets of theories and concepts, reveals how ERP-based MCS practices at SunPlants promoted DC, RR, and RO over the last seven years, as part of their significant digitalization progress.

1.6 Summary of main findings and contributions

The three empirical chapters outlined here demonstrate the generative process by which MCS changes are produced by ERP (Chapter 3), the forms of the ERP-based changes (Chapter 4), and relationships within the ERP-based MCS change (Chapter 5). The MCS changes are also analyzed in accordance with their impact on dynamic capabilities that lead to competitive advantages. Each of the empirical chapters makes a three-fold contribution, with the main findings and contributions detailed in the later three subsections.

1.6.1 Main findings and contributions of the first empirical chapter

The first empirical chapter aims to address the first research objective, which is to investigate the impact of the post-upgrading of ERP on CRM practice and changes and discover possible ways of using ERP-based MCS to develop three different dynamic capability routines. Drawing on the organizational routine theory, this chapter shows that the ERP-based MCS changes may appear as three ways of improvement at the micro-foundation level: first, the information connection at the artifact aspect; second, the action pattern abstraction at the ostensive aspect; and third, the bottom penetration at the performative aspect. ERP-based MCS changes appear as the incorporation of three terms: ostensive aspects, performative aspects and various artifacts. The changes that occur at the micro-foundation level directly promote CRM practices to develop the seizing and reconfiguring routines but not the sensing routine. The changes also confirm the essential interdependencies between (digital) technologies and MCS (Dechow and Mouritsen 2005).

The first empirical chapter makes the following contributions. First, it contributes to the MCS-ERP literature by revealing and tracing how the three major ERP upgrade-based MCS changes have been created (i.e., through enhanced information connection at the artifact aspect, action pattern abstraction at the ostensive aspect, and bottom penetration at the performative aspect). The impact of the post-upgrading of ERP on accounting practices has been recognized (Wagner *et al.* 2011), however the existing MCS-ERP literature might have no opportunity to observe the post-upgrading of ERP. This chapter bridges this research gap by focusing on the post-upgrading of ERP.

The chapter also highlights that the ERP upgrade-based MCS changes may occur simultaneously at various levels (i.e., the ostensive aspect, performative aspect, and the artifacts aspect), instead of appearing at the level of information or physical systems (Dechow and Mouritsen 2005; Quattrone and Hopper 2005) in the initial ERP adoption.

Knowledge about the three changes could suggest future MCS-ERP studies, especially those concerning the post-upgrading of ERP, focusing on how MCS changes occur simultaneously at various abstract and concrete levels.

Second, the three constructs developed in this chapter (i.e., accounting and operational artifacts, and common artifacts) might theoretically contribute to the organizational routine theory. These three concepts respond to recent calls to build connections between capabilities and organizational routine (e.g., Howard-Grenville and Rerup 2016; Parmigiani and Howard-Grenville 2011).

Accounting and operational artifacts represent specific artifacts that are produced in different operational (performative) areas. In this chapter, they are characterized as having different functions, posting/update times, and connections (i.e., widely connected, or isolated). Common artifacts show how specific artifacts are further connected, transformed, and maintained (common artifacts) for effective decision-making and control practices in three core strategic routines (e.g., sensing, seizing, and reconfiguring routines). These three constructs suggest possible future organizational routine theory-based studies: accounting and operational artifacts could work together to promote and navigate the challenging process of creating and replicating new routines across multiple functional areas within a company.

Third, this chapter contributes to understanding the practical ways of developing DC by exploring how the impact of the post-upgrading of ERP on CRM and MCS differs in three different DC routines. Researchers have recognized the importance of studying the practical ways of developing DC to compete in increasingly dynamic environments (e.g., Ambrosini and Bowman 2009; Dixon *et al.* 2014; Salvato and Vassolo 2018; Zahra *et al.* 2006). I demonstrate how the specific benefits (e.g., the broader physical memory space for transaction recording) involved in the post-upgrading of ERP improve the concrete accounting practices (e.g., accounts receivable) of CRM in order to facilitate specific customer-related actions leading to different DC routines. This informs the senior managers, who may not have had satisfactory ERP experiences, to notice that ERP per se might not promote accounting practices. Accounting practices could therefore be promoted by ERP when specific ERP functions and modules are properly selected and implemented.

Furthermore, I reveal the critical role of the flexible use of other digital artifacts producing engineering data to facilitate ERP and MCS to the three DC routines. This knowledge suggests to those managers who wish to make the business-accounting integration (yè cái róng hé, 业财融合[16]) that this integration is not merely about merging data. It is also concerned with the use of physical-digital technologies to make extensive data collection, extraction and connection, and business process reduction.

1.6.2 *Main findings and contributions of the second empirical chapter*

The second empirical chapter aims to address the second research objective: to investigate how the post-upgrading of ERP impacts MCS configurations and reconfigurations, and how they enable resource reconfiguration in the context of material resource-related actions. Adopting the notion of studying MCS as a package, this chapter reveals that the ERP-based MCS changes that promote material resources-related actions lie within three configuration forms: the basic, intermediate, and advanced forms. The three forms describe how MCS techniques are configured and reconfigured to cope with different levels of complexities of resources and actions. Each form also produces varying levels of visibility, recognizability, and controllability of material resources and related actions, leading to different methods of resource reconfiguration.

Additionally, based on the three forms, this chapter recognizes the importance of the dynamic fit between structural rigidity and functional flexibility of ERP in maintaining effective MCS reconfiguration and control outcomes for reconfiguring resources. In this way, MCS can maintain and alter organizational action patterns to stabilize the company while preventing radical modification of existing principles in dynamic conditions.

[16] This term is popular in China's accounting research arena, which could be basically understood as the integration of the management accounting tools and methods based on business processes.

The second empirical chapter makes three contributions. First, it empirically contributes to the MCS-ERP literature by providing initial evidence on the impact of structural rigidity and functional flexibility of ERP on enabling various MCS configuration forms. Such new evidence also implies that MCS and ERP that work together in dynamic conditions may be sensitive to the fit between structural rigidity and the functional flexibility of ERP. This evidence is important in order to update the MCS-ERP literature, because existing studies that are primarily based on relatively stable conditions do not reckon with the emergent IT infrastructure and MCS changes that serve to stabilize a company's operation in dynamic conditions. The evidence could also suggest that future MCS-ERP studies embrace the multiple aspects (e.g., structural vs functional) of ERP and how each aspect affects MCS integration.

Second, this chapter contributes to Malmi and Brown's (2008) theoretical framework by clarifying how individual MCS techniques are configured and reconfigured. This incremental contribution is important because it theoretically contributes to the limited but essential understandings of how multiple MCS techniques are actually configured and reconfigured in a company (e.g., Bedford *et al.* 2016; Malmi and Brown 2008; Otley 2016; Sandelin 2008).

Not only does it confirm the existence of the combinative form of MCS techniques in the case company, but also it indicates that ERP might be critical in realizing the combinative form of MCS practices. Additionally, ERP-adopting companies might rely on the coexistence of multiple MCS configurations. This understanding could suggest that the future studies that are based on Malmi and Brown's (2008) framework consider, first, the multiple instead of the single MCS configurations and second, technology-in-use that might make the MCS configurations differ.

Third, identifying three MCS configuration forms offers practical insights into accounting digitalization as an area that challenges the current accounting practice (Bhimani and Willcocks 2014; Quattrone 2016). The three forms of MCS configurations allow us to capture how the MCS configuration is constructed in terms of visibility, recognizability, and controllability, and how the configuration varies across various levels of action dynamics and complexities. Such three forms broaden the scope of MCS practices by producing visibility by numbers and reporting, to offering decision alternatives using analytics via digitalized means.

1.6.3 Main findings and contributions of the third empirical chapter

The third empirical chapter aims to address the third research objective, which is to explore how the post-upgrading of ERP leverages the sophisticated use of MCS in new product development practices, and traces how the leveraging effect enables resource orchestration for NPD. Guided by the levers of control theory, this chapter discovers that the ERP-based MCS changes manifest as a complementary relation. This means that MCS changes might not occur in isolation. Moreover, the complementary relationships are shifting across various strategic routines, timeframes, actors, and objectives involved in NPD and are associated with different technical features.

This shifting relationship is embodied as the different ERP-based complementary uses of diagnostic and interactive levers. Subsequently, MCS practices are used for structuring resource portfolios through monitoring resource movement and motivating actors' behavior, bundling resources into the NPD capability to meet rapidly customer needs, and leveraging the capability to be distinctive and sustainable through the mutual translation of business and data. Additionally, senior management involvement, the presence of the interactive team and reflective actors may determine the leveraging effect of the shifting complementary relation on resource orchestration.

Based on these findings, this chapter makes three key contributions. First, this study extends the MCS-ERP literature by revealing the shifting complementary relations of ERP-based MCS changes. Existing ERP-based MCS literature does not focus on the complementary use of MCS to delve into ERP-based MCS practices (e.g., Kruis *et al.* 2016), but existing MCS-ERP literature is limited under either abstract MCS terms (e.g., Dechow and Mouritsen 2005; Malmi and Brown 2008) or specific MCS practices (e.g., Chapman and Kihn 2009; Wagner *et al.* 2011). The shifting complementarity relation is based on understanding the diagnostic and interactive levers but is not explicitly studied by prior LOC-based studies.

This contribution is essential to extend the MCS-ERP literature because the shifting complementarity relations explain how various actors (the subjects of the relation) work with ERP to engage in different but congruent decision-making and control practices. The shifting complementarity may suggest that future MCS-ERP literature consider more complex decision-making situations[17] in order to explore how ERP contributes to the concurrent multiple MCS changes.

Second, understanding the shifting nature of the complementarity relation might contribute to the LOC theory because it reveals more concrete and specific terms involved in the decision-making and control process. The terms indicate the different actors involved (e.g., the controlling actors and the controlled actors, interactive team, and reflective actors), the changing control objectives, and the varying timeframe of enacting MCS in establishing the complementarity of the diagnostic and interactive levers. Developing the understanding of LOC and the levers' complementarity is critical to know how to steer MCS-in-use so as to stabilize the operation or progressively change a company's strategy (e.g., Frow *et al.* 2010; Simons 1994; Tessier and Otley 2012).

While the majority of existing LOC studies have explored LOC in isolation (e.g., Abernethy and Brownell 1999; Bisbe and Otley 2004; Kober *et al.* 2007; Widener 2007), the shifting complementarity is consistent with, and may extend, recent studies that explore the combined impacts of pairs of levers (Mundy 2010; Tessier and Otley 2012). This understanding may suggest that future LOC-based studies investigate how multiple complementary relationships develop between a particular period in order to meet specific business strategies.

Finally, detailing SunPlants' experience of post-upgrading of ERP to promote production and R&D might also have some practical significance. Although the finding

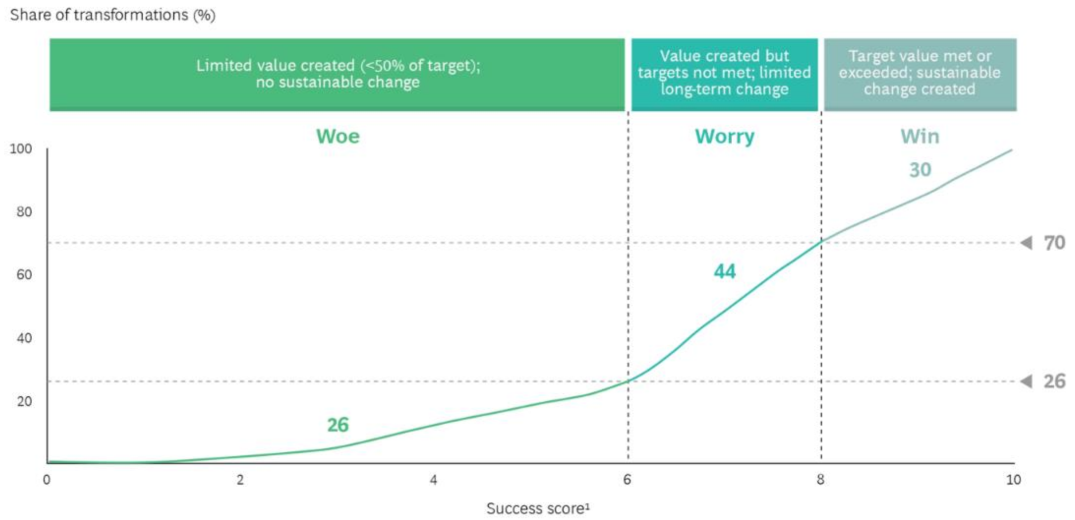
[17] That is, a setting where not only there is no obviously correct choice but also there are multiple answers that warrant further and more times of experimentation before committing to a single approach.

is not an ERP project guidance, it indicates those companies that will make the ERP upgrade in order to notice the potential risks of the intense use of formal communication channels. This chapter also characterizes the interactive team as the main force in the SAP-based complementary use of diagnostic and interactive levers and reflective actors as special ERP users, encouraging ERP-adopting companies to find them out from the ERP users. This suggests that senior managers of ERP-adopting companies identify their interactive team(s) and the reflective actors, in order to help the company to make progressive MCS changes leading to better organizational performance.

1.7 Thesis outline

The rest of this thesis consists of five chapters. The next chapter (Chapter 2) concerns research methodology. Chapters 3 to 5 are three self-contained empirical studies, where I review the relevant literature and report the empirical findings. Finally, Chapter 6 concludes by summarizing the findings, highlighting the contributions and implications, and acknowledging the limitations.

Diagram 1 Only 30% of digital transformations are successful



Source: BCG analysis, https://www.bcg.com/publications/2020/increasing-odds-of-success-in-digital-transformation

The success score is calculated based on the percentage of predetermined targets met and value created, the percentage of targets met and value created on time, the success relative to other transformations, and the success relative to management's aspirations for sustainable change.

From a comparative point of view, successful transformations created, on average, 66% more value, improved corporate capabilities by 82%, and met 120% more of their targets on time than those in the woe zone. Compared with the worrisome transformations, winners created 29% more value, improved capabilities by 20%, and met 32% more targets on time.

Chapter 2. Methodology

This chapter explains why and how this thesis employs a qualitative case study approach across the three empirical chapters. There are six sections. The first justifies the use of the epistemological stance of social constructionism, followed by the second, which explains why a single case study was selected to analyze the phenomenon in-depth. The third section describes how the data were sourced from interviews and documents in the case company. The fourth section depicts how the data were analyzed, patterned, and organized into the three main empirical chapters, and the fifth shows how measures were taken to ensure validity and reliability of this qualitative research. The sixth section provides details of the case company and the organizational context under study.

2.1 Philosophical underpinning: an epistemological view of social constructionism

This section explains why the epistemological view of social constructionism helps to examine management accounting practices and how this epistemological view affects the methodological choices made in this thesis.

2.1.1 The social construction of management accounting

The research objectives can be best addressed from the epistemological view of social constructionism. This epistemological view helps to clarify the objectives in three ways: first, the nature of management accounting in the organizational reality; second, the means by which management accounting is carried out in the organizational reality; and last, the requirement for management accounting to be context-sensitive in the organizational reality.

First, social constructionism helps in understanding the representation and construction of organizational realities by management accounting. Social constructionism contends that there is an objective reality, but that human beings continually construct the reality

(Berger and Luckmann 1967; Boland 1979; Burr 1995).[19] Management accounting research based on case study methods has increasingly been undertaken from a social constructionism perspective and has been recognized that accounting has not only been involved in the representation of reality (e.g., Solomons 1983; Solomons, 1991), but it has also constructed the reality (e.g., Bay 2017; Dechow and Mouritsen 2005; Parker 2012; Robson 1992).[20]

Carmona *et al.* (2002, p. 243) state that: "Accounting practices reinforce particular meanings of, and frequently create new meanings for, physical space… physical space becomes an accounting expression that can be valued, analyzed, and ordered". Ezzamel (2005) states that the effects of accounting are dependent on how they are made meaningful to their recipients. In other words, management accounting is socially constructed but not pre-existing in organizational realities. Management accounting is involved in the social construction of organizational realities. For example, budgets are created by actors in a company and then influence the actors' organizational behavior. Hence, studying management accounting does not merely involve studying the techniques, but also studying the human actors who are using the techniques (e.g., their experience and perception of using management accounting techniques).

Second, management accounting becomes a form of organizational language to create meanings of a particular organizational reality. Language is both a pre-condition for thought and a form of social action that is constituting rather than reflecting reality

[19] For example, according to Boland (1979), "Society is the product of human interaction and therefore the externalisation of subjective meanings, but society is also an objective reality which must be confronted. Through socialisation, man internalizes the objective reality and becomes himself a social product. Man creates the world through social interaction, and is created by it in the same process" (p. 265).

[20] Belkaoui (1978) argues that accounting "…shaped [its] users' perceptions [of reality]" (p. 98). In so doing, Belkaoui (1978) proposes that accounting acts as a constitutive force in organizational reality. Constently, Quattrone and Hoppor (2005) reveal that: "Accounting does not reflect reality but constructs it by providing particular forms of organisational visibility and power–knowledge relations" (p. 737). Moreover, according to Bay (2017):"Accounting is not only a technical practice used to report on economic activities, but also…employed to intervene and transform human economic behaviour in public and organisational life" (p. 45).

(Young and Collin 2004). Social constructionism centers on the use of language in relation to the daily interactions between human actors. It also describes how management accounting as a language expresses, shares, and creates meanings (Burr 1995; Campbell 1999; Edley 2001),[21] promoting human actors to coordinate with others rather than existing separately as an individual (e.g., Alvesson 1993; Burr 1995; Campbell 1999; Gergen 1994; Leeds - hurwitz 2009; Robson 1992).[22]

Some researchers have shown that accounting has its own language (Belkaoui 1978) and is a form of rhetoric (e.g., Alvesson 1993; Edward Arrington and Schweiker 1992; Klamer and McCloskey 1989; Robson 1992).[23] Accounting as a language is used to improve the ambiguity inherent in organizational reality and life (e.g., Alvesson 1993;

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[21] For example, Edley (2001) said: "Instead, a constructionist might point out that Nottingham is a city by virtue of a text (i.e., by royal decree) and that its boundaries where it begins and ends — are also a matter for negotiation and agreement. The argument is not, therefore, that Nottingham doesn't really exist, but that it does so as a socially constructed reality" (p. 439).

[22] For example, accounting scholar, Robson (1992) states that "rather than assume that language is a "window" to the world, it is argued that we have no access to reality other than through structures of representation such as speech and writing, structures which have their own categories, codes and consequences… (p. 690)". Alvesson (1993) states that individuals use language to construct and share subjective and personal meaning, and then when individuals accept and take these inter-subjective meanings for granted, these meanings appear as naturalized and objective elements of reality. Gergen (1994) indicates that language not only corresponds to facts but also language fits into social actions and supports coordinating the actions of the human actors involved in the action. According to Burr (2003), "language is nothing more than a clear, pure medium through which our thoughts and feelings can be made available to others, rather like a good telephone line" (p. 48). Campbell (1999) gives a more comprehensive comment: "We have now travelled a long way from the idea that language is a medium to connect the self to reality. Social constructionists take the view that we use language to coordinate the relationship between ourselves and our audience and, through the coordination, to arrive at a meaning for what we are doing and what is going on around us. The coordination seems to work something like this: in social settings, we are continually negotiating with others about how to position ourselves, or "how to be", in order that others will acknowledge us, attribute meaning to our behaviour, and make us accountable for who we are and how we are behaving" (p. 17).

[23] Rhetoric is about how people use language in social settings. Accounting operates not only as a numerical or even digital inscription device for long-distance control but also as a form of rhetoric to make a persuasive or impressive effect on people's behavior (e.g., Klamer and McCloskey 1989). Further, linguistic and social processes lead the meanings that actors construct in daily interaction to take on a level of 'objectivity' that makes those meanings look as real and inescapable as the constituents of the natural world (e.g., Gergen and Gergen 1991).

Morgan 1988).[24] According to Bloomfield (2008),[25] accounting is used to construct the appearance of knowledge (e.g., financial information informing the periodic performance of a hospital) to provide meaning and legitimacy to organizational practices and beliefs. In most cases, we use management accounting (e.g., planning) to transform qualitative “reality” into quantitative accounts (Bay 2017), fitting an external reality to a coherent representation (Mouritsen 2011). Hence, studying how management accounting as a language is used to maintain stable objectivated meanings and realities helps to understand the social construction of management accounting in organizational realities.

Third, social constructionism describes how accounting as a language is context-sensitive rather than context-free in practice. We cannot deny that knowledge, concepts, and constructs correspond to concrete objects in the real social and cultural contexts (Berger and Luckmann 1967; Campbell 1999). As management accounting is socially constructed (e.g., Tinker 1985), it cannot be understood in isolation from the social and physical contexts (e.g., Dechow and Mouritsen 2005; Evans 2010; Kuchta and Sukpen 2011; Robson and Bottausci 2017). Their contexts vary between communities (e.g., Bhimani and Willcocks 2014; Burr 2015; Gunnarsson *et al.* 2014; Quattrone 2016; Urciuoli 2013),[26] and thus, “there is no universally appropriate accounting system which applies equally to all organizations in all circumstances” (Otley 1980, p. 413). In

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[24] For instance, accounting control systems were introduced to hospital management to lead to an undue emphasis on the financial aspects of a hospital at the expense of its caring responsibilities (Morgan 1988).

[25] Bloomfield (2008) demonstrates that “People communicate through written natural languages by selecting words from a standard vocabulary, combining them in meaningful ways according to relatively rigid rules of grammar, and then organizing those words into sentences according to relatively flexible rules of syntax and style that allow shades of emphasis and color. People communicate through accounting reports by selecting accounts from a standard vocabulary, combining them in meaningful ways according to the relatively rigid rules of double-entry bookkeeping, and then organizing those words into financial reports according to relatively flexible rules of presentation” (p. 433).

[26] For example, Bhimani and Willcocks (2014) indicate that: “Contextual differences in allocating, coordinating and monitoring practices involved in organizational controls that are inherently part of certain managerial styles.” Quattrone (2016) indicates that: “the development of accounting has been historically linked to humanist culture and more specifically to rhetoric, conceived of as a method of knowledge classification and invention and not merely as a technique of persuasion.”

other words, management accounting practices are company-specific and even object-specific.[27]

These context-sensitive management accounting practices should be studied by way of the interaction of human actors using management accounting techniques rather than the presentation of the techniques' performance effects. The epistemological stance of social constructionism rests on the notion that knowledge,[28] concepts, and constructs are jointly constructed by the interactions of human actors, rather than explored or discovered (Berger and Luckmann 1967; Campbell 1999; Levinson 1983). Hence, studying management accounting practices should be better immersed into the context in which the interaction occurs, rather than by merely observing human actors' interactions.

In summary, based on social constructionism, this chapter examines how human actors use management accounting as a language to interpret themselves, the situations they encounter and then reproduce. The next section uses a set of methods and principles to explore the social construction of management accounting.

2.1.2 Methodological concerns

Based on the epistemological features of social constructionism, I adopt a single qualitative case study to examine the interactions of the actors using management accounting systems. As opposed to employing quantitative methods (that may have previously been considered the best way to offer a general understanding of this phenomenon (e.g., Bromwich and Scapens 2016)), I use a qualitative method for three reasons; namely, the translation of subjective experiences and language, the focus on the relationality, and the involvement in the process and interaction.

First, qualitative research helps to capture the nature of management accounting in

[27] For example, the profit of a company means the profit generated by this company. The overhead of a product means the indirect expenses associated with the processes used to produce this product in a particular company and control the process that induces the expenses rather than other processes.

[28] For example, the most fundamental, taken-for-granted common sense knowledge of daily life.

practice. According to Berger and Luckmann (1967, p. 256), there is methodological guidance:

> "First, they should discover the meanings which local terms have for actors, rather than impose ready-made definitions on situations. Second, they should discover the social rules through which these terms are ordered… Third, they should study how terms and rules come together to create particular ``dramatic" settings, with their own plots and narratives, in which action takes place. Fourth, they should uncover the further set of social rules by which plots and narratives are created, justified, and transmitted to others".

The qualitative research methodology helps to translate the meaning of subjective experiences and language that we use in our interactions with other individuals and in drawing upon meanings that we share with those with whom we interact. In addition, following the qualitative methodology allows the research participants (i.e., the actors using MA techniques) the opportunity to fully and freely describe their own experiences and listen carefully to others' views. I then translate the findings based on their background, experiences, and the context in which they interact with others, revealing a significant amount of information concerning the reality under investigation.

Second, the qualitative methodology is useful for tracing the use of languages in management accounting practice by focusing on the relationality associated with the social construction of organizational reality (e.g., Fletcher 2006; Gergen 2001; McNamee and Hosking 2012) rather than a division between objectivity and subjectivity in reality. The use of language in social construction emphasizes that human beings continually construct the reality to which they must respond (Berger and Luckmann 1967). Similarly, Giddens (1984) has emphasized the relationship (rather than the differences) between dualistic qualities in order to study reality. Subsequently, Feldman (2016, p. 26) suggests, "refocusing on enactment rather than representation, on process and potentiality rather than likelihood, and on relationality rather than correlation" (Feldman 2016, p. 26).

Qualitative methodology values openness and flexibility, allowing this research to be action-oriented in making good use of the insights gained. Subsequently, the relationship "between people, institutions, material objects, physical entities and language" can be revealed (Fletcher 2006, p. 422).This study can therefore produce knowledge that is based on the premise that whatever is being investigated must be considered as a configuration of relationships (e.g., Capra 1996; Newton *et al.* 2011), rather than an independent, "objective" entity (e.g., Astley 1985; Bradbury and Lichtenstein 2000; Foucault and Gordon 1980; Lincoln *et al.* 1985).

Third, qualitative methods allow the researcher to be intimately involved with the context in which the interactions occur, rather than using a values-free toolkit that maintains an objective, detached stance to measure observations and collect quantitative numbers about the functional components. Social constructionism asserts the processual nature of self (e.g., Mahoney 2003), the contextualized and historical nature of knowledge (e.g., Cunliffe 2008), multiple factors in the collection or interpretation of the "social data" (Bingle and Gaskell 1994). Young and Collin (2004, p. 377) state that, "Social constructionism covers a range of views from acknowledging how social factors shape interpretations to how the social world is constructed by social processes and relational practices". Hosking (2002, p. 7) indicates that ''all constructed realities and relations are produced and emergent in relational processes''.

In this study, I do not intend to participate in the debate on whether the reality is a process or the process is part of the reality. Social constructionism helps to examine how reality involves processes and interactions rather than merely functional components and representations. Gergen (1999, 2001) argues that it is not empirical methods (such as experiments) that are incompatible with social constructionism, but the universalistic truth claims that usually accompany them.

In summary, the qualitative research approach has a direct focus on the "dynamic unfolding" of processes. The next section explicates how to produce new understandings about the daily interactions involved in MA practices that take on meaning and significance not captured in quantitative numbers (Emirbayer 1997), the meanings that are negotiated and shared through social processes (Fletcher 2006), and rationality that is created, sustained, negotiated, and modified.

2.2 Research method: a single case study approach

This section describes why a single case study approach is used and how this case was selected.

2.2.1 *A single case study approach*

This study employs a single case study for a more in-depth analysis of management accounting practices in a particular context. Using a case study helps to investigate "one or a small number of social entities or situations about which data are collected using multiple sources of data" (Easton 2010, p. 119). This achieves triangulation by exclusively concentrating on ongoing considerations of actions and behavior in certain contexts (Ackroyd 2010, p. 535), enabling us to deal with "the technically distinctive situation" (Yin 2003, p. 13) where there must be "more variables of interest than data points" (Yin 2003, p. 14). There are three key reasons for employing a single case study method.

First, this approach can be used for an in-depth analysis of an unusual ERP-based MCS practice in the context of China's rapid digitalization-based transformation. Accounting digitalization has become a fact within the real organizational life of the 21st century, however, it is not fully understood. The phenomenon of accounting digitalization from the ERP-based MCS perspective in the context of digitalization transformation is inherently connected. For example, accounting digitalization functions as a supporting force in the transformation process, while concurrently supporting the digitalization of management accounting's underlying infrastructure. Understanding accounting digitalization and digital transformation may continue to push through the boundaries of our knowledge of organizational realities.

A single case study helps to avoid the risks of reducing complex phenomena to a few comparable variables, resulting in the loss of the idiosyncrasies of individual cases (Stoecker 1991). Yin (1984) and Yin and Davis (2007) suggest that an in-depth case study method helps to investigate a complex phenomenon that takes place within a real-life context that cannot have clear boundaries with the phenomenon under study.

According to Creswell (2013, p. 97), a case study is understood to be something that:

> "Explores a real-life, contemporary bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information… and reports a case description and case themes."

A particular set of management accounting practices are both relying on and reproducing the context in which they operate. Furthermore, ERP-based MCS practices are very sensitive to the context-specific impact, as stated by Wagner *et al.* (2011, p. 194) that "an ERP system will look and function quite differently in each context, sometimes the assemblage will enable reconfiguration while in other situations it will not." Arguably, in contrast with field studies[29] that do not pay enough attention to the context of the phenomenon and the entanglement of the practices and the context (e.g., Granlund and Malmi 2002; Scapens and Jazayeri 2003), the case study approach is appropriate in studying the ERP-based MCS practices in the context of rapid digitalization-based transformation. The case study approach involves multiple data collection methods (e.g., interviews, informal chats, documentary data, and online data) from organizational behaviors and actions (Woodside 2010). By identifying and analyzing data from different sources, the case study fits the inquiry focus on interaction, processes, and social practices (Young and Collin 2004).

Second, when compared with the multiple case study approach, a single case study approach can eloquently describe the phenomenon in a particular setting (Siggelkow 2007). This thesis could explore various MCS forms as languages to construct a particular organizational reality through a single case study. The single case study may thus lead to the discovery of less formal forms of MCS practices (e.g., Collier and Hoeffler 2005; Greenhalgh 2000; Perren and Grant 2000), because it is a sensitive, deep-probing research method; for example, a single case study may enable the tracing of subjectively constructed forms of control (Sandelin 2008). Thus, a single case study appears to be the most promising mode of inquiry because it makes a comprehensive

[29] Admittedly, field studies help "get a wide and comprehensive picture of the new phenomenon" (Granlund and Malmi 2002, p. 302).

approach to the study of controls in use possible (e.g., Ahrens and Dent 1998; Otley and Berry 1994; Scapens 1990).

Third, a single case study outperforms multiple case studies in that it offers an in-depth analysis of the specific contextual conditions that matter in the everyday situation of ERP-based MCS practices (e.g., Ahrens and Chapman 2007; Dyer and Wilkins 1991; Otley 1980; Otley 2016).

In particular, a single case study supports the intention of "way-finding" rather than "navigation" (Chia and Holt 2009; Suchman 1987), meeting the revelatory purpose of this research in the emerging context of the rapid digitalization-based transformation (Yin and Davis 2007). The function of "way-finding" helps to determine the research objectives in order to address the ERP-based MCS practices. Meanwhile, a single case study allows for the novelty emergence, rather than the predictability, of outcomes (Garud *et al.* 2015). Previous research has had no ability to study the MCS change that occurs after an ERP upgrade.[30] A single case study contributes to the continuous knowledge generation process of the ongoing and dynamic interplay of MCS and ERP.

2.2.2 Case selection criterion

The case company was anonymized as "SunPlants" in this study. SunPlants has unique characteristics that make it suitable for a case study, as one of the largest clean energy equipment manufacturers in the global petroleum industry and a successful SAP project company in this industry. As a case company, SunPlants is characterized as building its core competencies through continuously improving its digital infrastructure over the last 10 years (see Diagram 2, for more details, see Section 2.6).

[Insert Diagram 2 Brief overview of the IS development at SunPlantshere]

SunPlants was selected as the case for the following reasons. First, it offers a typical case wherein ERP is used for both decision-making and control purposes. When most

[30] There is a misfit between the practices of continuously updated digital technologiesand MCS. Subsequently, there is a lack of required on-going understandings about the effect that ITs and MCS have on organizations and performance.

Chinese companies still face a high ERP failure rate, SunPlants has enacted the ERP-based MCS practices that cover most of its operational actions.

The failure rates of ERP in China have been higher than in Western countries (e.g., Ge and Voß 2009; Zhang *et al.* 2005). The high failure rate is a chronic problem that has plagued Chinese companies in particular for some years (e.g., Lai *et al.* 2016; Li 2011; Li *et al.* 2017b), inhibiting the development of organizational agility and dynamic capabilities (e.g., Chi *et al.* 2008; Pavlou and El Sawy 2006; Sambamurthy *et al.* 2003). Presumably, SMEs that have succeeded in digital transformation are not the norm.

During the data collection process, SunPlants employed the SAP ERP as its main decision-making and control systems (i.e., MCS) and functions as the core enterprise system, acting alongside other information systems and digital technologies (e.g., operation systems, engineering systems). The ERP (SAP) that SunPlants currently operates has helped to secure its dominant role in the compressor industry in recent years.

In reality, although decision-making and control supports are typical functions of ERP, some companies have adopted ERP merely as a means to support decision-making only (e.g., providing periodic performance reports) (e.g., Aslan *et al.* 2015); they do not use ERP as a control mechanism (e.g., affecting employee behavior and organizational actions). Using SunPlants as a case study helps to avoid insufficient observations relevant to ERP-based MCS practices, generating more in-depth analysis and findings that are not well-investigated by existing MCS-ERP research.

Second, SunPlants is characterized as having an unusual experience in the post-upgrading of ERP that occurred in 2013. Before 2013, SunPlants had a “bad experience” of adopting ERP, followed by a “good experience” through the upgraded ERP (SAP). At the time of the interviews, the SAP system was being used as the foundation of the digital infrastructure. SunPlants is currently attempting to advance its digitalization practices via big data and cloud technologies, to better cope with external challenges. Despite ERP upgrades becoming more prevalent in China over recent years, the research access was not available for earlier studies, so researchers had no opportunity to observe or analyze the post-upgrading and relevant MCS practice. This case study offers revelatory accounts concerning the phenomenon by examining “what ERP can do”, “what ERP cannot do,” and “what causes success and failure”, which may reveal information hitherto unknown.

Third, SunPlants adopted a Manufacturing to Order (MTO) production strategy, providing an alternative context by which to study the ERP-based MCS practices. Existing MCS-ERP research based on the case study approach has focused solely on Manufacturing to Stock (MTS), rather than MTO, which is associated with more intense and rapid competitive conditions and actions.[31] Different production strategies lead to various organizational processes and actions, thus differentiating how MCS is configured and used in ERP is relevant. Numerous investigations, such as Samadhi and Hoang (1995) and Sipper and Bulfin (1997), have discussed operating differences between MTO and MTS. MTS focuses on throughput and machine utilization, while MTO focuses on the due date and cycle time, with a rigid order release plan and dispatching control. Understanding the production strategy is critical to ERP implementation (Aloini *et al.* 2012), especially for the MCS change.

Fourth, SunPlants has enjoyed a considerable competitive advantage in previous years, even in the face of challenging situations within the energy industry, outperforming most rivals in this industry during the period when reforms required the transformation of the manufacturing industry. In other words, SunPlants has been able to rapidly develop external dynamics and secure competitive advantages. The experiences of SunPlants’ development may demonstrate distinctive capabilities that outperform its industry rivals (e.g., Patton 2014; Robinson 2014).

China's compressor industry is a suitable case, as this industry is essential to China's manufacturing industries. The client companies of the compressor industry are mainly the petrochemical industry, the electric power industry, metallurgy and mining, and the

[31] For example, Assemble to Order (ATO), Configure to Order (CTO), and Engineer to Order (ETO).

national defense industry, which are essential to the national economy and peoples' livelihood. China's compressor market reached 12.7 billion dollars in 2018 and is projected to rapidly increase due to the growing domestic automotive industry and construction sector.

However, although associated with increasing opportunities, the market becomes highly competitive. Most companies are involved in facility expansions and product launches to increase their business, therefore, studying the ERP practices in this industry is more likely to contribute to understanding possible accounting changes and the resulting strategic impact, especially for industries that are as dynamic and competitive as the compressor industry.

Investigating such a unique case is significant because its "findings may reveal insights about normal processes" (Yin 2017, p. 85). It also worth documenting and analyzing since the research objectives work together to emphasize the possibility of a specific path for the recent national reforms through digital transformation in China.

2.3 Data collection techniques

This section describes how interviews are used as the primary data collection method and how documentary evidence supplements the interview process. Research data were sourced using semi-structured interviews, documents, and online information, with a time span of up to seven years. This data collection strategy allows for cross-checking or cross-referencing the data (Batteson and Ball 1995; Spiggle 1994) by combining different perceptions of the same event to provide a more robust and holistic picture (O'Donoghue and Punch 2003; Tritter 1995).

2.3.1 The selection of the interview technique and interviewees

This section describes why the interviews and how the interviewees are selected in order to support employing semi-structured interviews as the primary data source. In the qualitative paradigm, interviews are often seen as one of the best ways to "enter into the other person's perspective" (Patton 2002, p. 341) and develop "thick descriptions of a given social world analyzed for cultural patterns and themes" (Warren 2002, p. 85), rather than to obtain purely quantitative methods, such as questionnaires (e.g., Smith 2006).

For this thesis, I conducted 67 interviews with 42 interviewees (for the interview scheme, see Appendix 1), between January 2018 and August 2019. The internal documents were sourced from various middle managers who were interviewed. Diagram 3 shows that the interviews are mainly concerned with how the ERP upgrade that occurred between 2013 and 2014 affects the MCS practices of SunPlants between 2014 and 2019. Inquiries were also made into some ERP-based MCS issues (the years prior to 2013 in Diagram 3) before the ERP upgrade, in order to understand MCS changes after the upgrade. Additionally, the interview period encounters the big data project. This thesis captures the chance to see how digital technologies based on ERP affect MCS practices.

[Insert Diagram 3 here]

Although the interviewees were busy, most were willing to talk about the related issues. The average interview time was approximately 40 minutes, ranging from five minutes to five hours. Some interviews lasted only a few minutes because some interviewees left to attend to urgent events, and there was no opportunity to talk with them again. The interviewees were from both SunPlants and its IT vendor, GoSoft, which has provided IT services to SunPlants for the last eight years. Together, they have built a long-term relationship so as to develop a national-level intelligent manufacturing system in upcoming years.

Incorporating the IT vendor into this research makes a methodological contribution to the literature. Whereas existing research conducted interviews primarily with the case company's internal users or internal consultants, this research has enlisted interviewees from both the case company and the vendor (external consultants). Although existing research emphasizes that little is known about how strategic efforts and lack of expertise are significant constraints for ERP configuration and modification (e.g., Dechow and

Mouritsen 2005; Smith 2006), it also pays little attention to the investigation of the ERP-based MCS practices from the perspective of the vendor supporting the ERP project or IT project implementation in a particular company. The vendor has an active role rather than a passive role in ERP adoption, and sometimes the role is dominant (e.g., Beatty and Williams 2006; Sarker *et al.* 2012; Seethamraju 2015). Arguably, those failed ERP projects are partly attributable to the vendor's inability to support a project's implementation. Merely understanding the ERP-based MCS from the user's (the company's) perspective results in a limited understanding.

SunPlants attributes the success of the SAP project and a big data project to the closely connected relationship between the case company and the vendor. They have built a recursive relationship between Business-IT problems and Business-IT solutions to support the three-to-five-year strategy of the case company.[32] This relationship is critical to the implementation of the ERP-based MCS practice (Wagner *et al.* 2011).

Existing ERP literature has revealed the importance of studying ERP implementation from the vendor's perspective. The ERP vendor's quality is critical to the ERP success of an adopting company (e.g., Ifinedo and Nahar 2007). Analyzing ERP from a vendor's perspective can improve understanding as to how an ERP is implemented in relatively compatible ways (Alshawi *et al.* 2004; Helo *et al.* 2008) and how the most effective way to perform a business process is carried out through the ERP (van Roekel and van der Steen 2019).

However, Wagner *et al.* (2011, p. 196) claim that "vendors who want to sell a standard 'best practice' product have not acknowledged the evolutionary nature of socio-material assemblages, including accounting practices." In other words, this research focuses on accounting practices, and does not merely analyze the phenomenon from the vendor's perspective. Hence, the adopting company's perspective and the vendor's perspective are complements in producing a complete view of the ERP-based MCS practices.

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[32] For example, the case company is the client of the Business-IT solutions and the co-supplier of the solutions.

Appendix 1 shows that 21 of the interviewees were SunPlants staff, with the remaining 21 interviewees from the vendor, GoSoft. SunPlants staff interviewees were from sales/marketing, procurement, production, R&D, quality control, and accounting departments. They were familiar with the ERP system (both the former system and the new system) and management control via ERP. Most interviewees have been promoted to middle management in the last five years. Among the 21 SunPlants' interviewees, one was the CEO at that time (who has since resigned and joined the vendor company in 2019). This CEO believed that digital technologies would form the next generation of manufacturing technologies, and that digitalization services can boost the potential of manufacturing or product services.

Among the 42 interviewees, some interviewees' responses were similar to those in the existing research (e.g., fast information access, more information for forecasting and planning). Interviews with them were completed quickly but with limited contributions. However, interviews held with the super users and key users[33] generated more useful contributions, as these users play a role in bridging the various components of business to IT, strategy to operation, and present to future, internal to external.

Vendor staff interviewees were consultants and engineers involved in the post-upgrading of ERP, big data, and SunPlants' clouding project. The vendor was one of the contractors of the SAP project of SunPlants.[34] With over 24 years' experience in implementing ERP projects and approximately 10,000 enterprise clients, GoSoft is a professional enterprise information service provider. In 2018, two big data projects conducted by them were deemed as national-level model big data projects; one of which was SunPlants' big data project.

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[33] A super user has scope to allot special authorizations (in the business process) to the key users. A key user accounts with special authorizations. For example, A is a super user, while B and C are key users of an SAP system. B and C do not have access to change the business process, but A as a super user with more authorizations has the access to modify others' authorizations. The super user is more likely to be the industry accepted and recognized role, who bridges the business to IT.

[34] Another contractor was a top-five enterprise information service provider in China (A-share listed company).

Gosoft established a special team to manage the big data and clouding projects, which enabled them to apply cutting-edge technologies to their work. Some team members were recruited as interviewees for this project, with backgrounds as professors, subject experts, and doctoral students from the top 10 Chinese Universities and national laboratories. In addition, there were also professionals and managerial consultants in ERP and digital technologies.

2.3.2 The interview process

This section deals with how the interviews were conducted. They dealt with the main issues encountered by the interviewees and their personal experiences in terms of changes in decision-making and control practices in critical functional areas through the post-upgrading of ERP (for details, see Appendix 2). This data helped to construct a model that is neither the three dimensions of space nor the four-dimensional spacetime, but rather, *multiple dimensions*, including physical, emotional, spiritual, intellectual, environmental, social, occupational, etc. For more details about the interviewees and interviews, see Appendix 1 for the outline of the interview schedule and Appendix 2 for interview questions.

Five measures were adhered to in order to maintain objectivity and sensitivity in collecting and analyzing data from the interviews. First, the interview questions were open-ended and non-leading, to avoid biasing the outcome. For example, “yes” or “no” questions or other leading questions were avoided (e.g., “Do you think the system is terrible?”; instead, “How do you feel about that system?”). Second, as the interviews were conducted in a real-life working environment within the company, a log was kept of specific actions by the interviewees during the interview process. For example, sales staff came into the office for an approval signature by the accounting managers who were being interviewed, therefore I could ask the managers why this manual approval was still required and record their response. Third, during the interview process, I kept track of the research objectives through the inter-subjective meanings over time, rather than the interviewees' subjective thinking. For example, I asked and recorded why an interviewee complained about the system, the rules or standards, or other colleagues, and recorded whether the incident was related to the research objectives (instead of referring to the complaints as direct evidence). Fourth, for each interview, interviewees were asked to provide real-life examples or stories, as much as possible, to support their responses. Moreover, I attempted to cross-examine the interviewees using previous responses given by them and other interviewees in order to support the quality of the responses provided. Fifth, I asked questions out of sequence from the interview guide if I considered it made more sense. For example, if one interviewee gave information relevant to question C while the interviewee answered question A, I did not interrupt the interviewee.

During each interview, I also ensured that all participants received structured information about the purpose and procedures behind the research, as follows: first, I provided a brief personal introduction and explained the nature and purpose of the research; second, I emphasized that their involvement could be discussed with others, and that they could take time to reflect on whether (or not) they wished to participate, and explained anything that they had questions about; third, I used layman's terms (local and simplified terms rather than scientific terms and professional jargon) to explain the purpose of the research ; fourth, if necessary, I explained why I had chosen them, in particular, to participate in the research; fifth, I emphasized again that participation was entirely voluntary, and that they could refuse to participate and withdraw at any time; sixth, I explained the interview procedure, duration and the type of questions that participants were likely to be asked; seventh, I emphasized that anonymity and confidentiality were guaranteed to each interviewee; and finally, I offered the plan for sharing the findings of the research with the them.

However, the interviewees were unwilling to allow me to use a recording device, perhaps due to issues around confidentiality or fear of repercussions. Therefore, I took detailed notes during each interview. I was more likely to record what I thought necessary and ignore what I thought was "not important" due to my own knowledge limitations during an interview.

Three main remedies are included in the study in order to avoid this negative impact: first, to undertake multiple interviews with some interviewees so as to allow more themes to emerge; second, to supplement interviews with documentary evidence to minimize bias and establish credibility; third, if new categories emerged due to the new data, I would then reanalyze the previous relevant transcripts of interviews, together with data from the various documents, to determine whether those categories existed elsewhere.

2.3.3 Documentary data

Document analysis is a low-cost way to obtain empirical data as part of a process that is unobtrusive and non-reactive. Bryman and Burgess (2002) define the qualitative analysis of documentary data as the search for underlying themes within the documents.

Diagram 3 shows how documents were sourced for this study in order to better understand the ERP-based MCS practices between 2013 and 2020. The documents are ERP project investigation documents, digital infrastructure reports, IPO prospectus reports, organizational profiles, and online information concerning the company and the industry (see Table 1).[35] The ERP project-related documents enabled the discovery of the interconnectedness of the ERP configuration and functionality with organizational actions and processes. Other documentary information helped to understand contextual information over the last 10 years.

[Insert Table 1 here]

Document analysis to supplement information gathered from the interviews was used in three ways. First, it helped to produce more detailed descriptions of a single event, organization, or program phenomenon within the case company (Stake 1995; Yin 1984).

[35] Among these documents, the ERP project investigation reports and the detailed report about the IT infrastructure are highly confidential. The providers emphasized and warned that I am not allowed to share the documents with anyone else, because these documents record very detailed business processes of the case company and the details about the use of the information systems in the business processes. Although the details of all the business processes would have changed over years, some core business processes were still creating advantages and values to the case company, at the time of the interview.

The detailed descriptions are suitable for sourcing a comprehensive understanding of the phenomenon under study. Also, according to Atkinson and Coffey (2004), documents offer “social facts” in relation to the ERP-based MCS practices and the operation of the case company, historically and prospectively. Documents are produced, shared, and used in socially organized ways, representing the inter-subjective meanings associated with a particular phenomenon (e.g., the configuration of SAP) (e.g., Gergen and Gergen 1991; Rapley 2011; Straus 2008).

Second, as a corollary to being non-reactive, documents are stable, especially the SAP implementation and IPO prospectus. The researcher’s presence does not alter what is being studied (Merriam 1988). Document analysis classifies contents in relatively objective ways by examining contents systematically based on a certain standard, offering information on questions such as “by means of, who, what, to whom, why, how, and which”. For example, the ERP project document was written as the project blueprint, which served as a project guide to determine the steps and set the entire project's progress.[36]

The reports were written by the consultants from the vendor, GoSoft. They were, at that time, experts in implementing and applying the SAP ERP and management control practices in this industry. The consultants involved were from all the levels of the SunPlants, for example, the general manager, chief engineer, CFO, departmental managers, and ordinary employees. More than 200 actions involved in the business processes were analyzed in the report, including departmental expense planning procedures, the contract review procedure, the contract modification and contract execution procedures, the R&D communication procedure, and the production order running procedure.

[36] The contents mainly concern with (1) the current business processes and relevant activities, (2) problems that exist in the old ERP and business process, (3) optimization goals. The one-hundred and fifty-page reports were based on interviewing sixty-three people across seventeen departments in SunPlants to (1) determine the identified needs of each business process, (2) identify the difference between the current business and the future business, (3) and offer a suitable solution via SAP.

Third, this study complements interviews by document analysis for three reasons. Document contents "teased out" problems that SAP could potentially offer solutions to but were not sufficient for addressing the problems that SAP could not provide solutions to. Documentary data fails to encompass critical contextual conditions pertinent to the study phenomenon (e.g., Yin and Davis 2007). These documents were created independently of a research agenda, focusing on technical and practical issues, and could not capture changes in the business process and digitalization infrastructure after a few years had passed. Hence, as the prime data source, these interviews captured the novelties of China's rapid digitalization-based transformation.

In summary, neither interviews nor documents alone could reveal how certain kinds of MCS invoke certain kinds of responses, behavior, and actions, or make clear the circumstances in which such kinds of MCS can (or cannot) be made possible. The analysis of interview transcripts and written texts of other kinds promote further understanding of the local terms used and inter-subjective meanings pertinent to the ERP-based MCS practices, as the practices are never stationary, impersonal, or irrelevant to the actors interacting within the ERP and MCS practices in the real-life actions of the organization.

2.4 Data coding and analysis

The use of Nvivo 12 helped generate codes and identify themes from the data. Appendix 3 shows the three-stage data analysis and coding process. The first stage created three free nodes in accordance with three distinct themes: first, CRM actions; second, material-related actions; and third, production and R&D-related actions. The nodes gathered information concerning the use of ERP and MCS, organizational performance and strategies, and the use of other digital technologies in three main sets of organizational actions and processes. During the coding process, I read and reviewed the data to determine the relevance to MCS practices,[37] organizational and strategic

[37] For example, "planning (jì huà)", "budget (yù suàn)", "procedure (chéng xù, bù zhòu, liú chéng)", "structure (jié gòu, jià gòu)", "account (zhàng hù)", "report (bào biǎo)", "cost (chéng běn)", "compensation (xīn chóu, gōng zī) ", "reward/incentive (jī lì) ", "accountability (zé rèn, zhí zé)",

actions. [38] I coded the broad context of the keywords to avoid any misunderstanding of the meanings (for example, see Diagram 4). Subsequently, in the writing-up stage of the study, each theme is presented by a self-contained empirical chapter.

[Insert Diagram 4 here]

The second stage created tree nodes for each theme and empirical chapter by reviewing the coded contents. Appendix 3 shows the tree nodes created in each empirical chapter. The first stage and the second stage do not follow a linear process. The second stage searched for keywords in accordance with the three main themes of the free nodes (i.e., CRM actions, material-related actions, production and R&D-related actions). Next, I defined the keywords and contents in relation to the MCS practices. To avoid the content code being general, vague, and "theme irrelevant", I maintained the linkage between ERP, MCS, organizational performance and strategies, and the contextual conditions. The themes related to the development of dynamic capabilities were also coded and organized by different DC concepts (e.g., three DC routines, RR, and RO). Each DC concepts are captured by their own specific constructs reflected through child nodes (see Appendix 3). Finally, I used additional tree nodes to capture and trace the emergent issues and themes into the categories for analysis.

The third stage created child nodes for each tree node. Thirty-seven child nodes based on the free nodes of three main themes were created. The child nodes are identified by

"performance (jì xiào), "process (liú chéng)", "communication (gōu tōng)", and so on.

[38] For example, during the process, I gathered codes relevant to the routine associated with maintaining customer relationship, keywords related to activities with customers are used, such as "sales (xiāo shòu)", "marketing (yíng xiāo)", "order (dìng dān) ", "product (chǎn pǐn), "after-sale (shòu hòu) ", "return (tuì huò)", and so on. For the second chapter, codes were created in relation to material-related activities in the case company. I used keywords in the coding process, such as "material (wù liào, cái liào, yuán cái liào)", "procurement (cǎi gòu)", "stock (kù cún)", "receiving (shōu huò)", "pick up (lǐng liào)", "component selection (xuǎn jiàn)", "BOM" and so on. In the third chapter, keywords were mainly those related to production and R&D activities, including "(R&D prototype) drawings (tú zhǐ)", "design (shè jì)", "research (yán fā)", "routing (gōng yì)", "coordination (xié tiáo)", "machine (shè bèi)", and so on.

reviewing the coded contents based on the conceptual framework in order to fully trace the interaction of accounting, people, technologies, and contextual conditions, capturing the phenomenon's urgent status.

In the coding process, the nodes were not created in isolation. They are interdependent because some of their contents overlap. This study has also ensured that the Chinese translation into English could capture all the relevant data and information by using both Google translation and Youdao translation. There are multiple Chinese translations of one English word, for example, “procedure” (chéng xù, bù zhòu, liú chéng). Thus, I have coded the content with multiple Chinese translations, other than only those I knew.

Furthermore, to ensure that the nodes, original data, and findings are not clearly linked together, I provided a chain of evidence (see Appendix 4). This chain of evidence illustrates how the findings are revealed and validated through themes based on specific concepts, child nodes, interview quotes.

2.5 Validity and reliability

This section explicates how validity and reliability were maintained throughout the research process. Validity and reliability are typically viewed as essential criteria of a study's “goodness” (Saunders *et al.* 2009). However, in conducting a case study it is relatively easy to cause concerns regarding methodological rigor (e.g., Campbell 1973; Daft and Lewin 1990; March 1991; Miles 1979). Positivists often find qualitative research lacking when validity and reliability criteria are applied in qualitative research (Ahrens and Chapman 2006). This thesis adopts Yin’s (2003) criteria of using internal validity, construct validity, and reliability, and Parker and Northcott’s (2016) criteria of using theoretical generalization to evaluate the quality of a case study.

According to Yin (2003), construct validity concerns whether we measure what we want to measure and usually takes place in the phase of data collection and composition. This study copes with construct validity in three ways: first, I attempted to understand how existing research in related topics measure and operationalize their constructs in relevant research contexts; second, I employed various data collection techniques, such as in-depth interviews, internal documents, and other external sources of information related to the topic; and third, I matched the findings through discussion with the key interviewees and by employing the chain of evidence, which ensured that the data was correctly collected from the interviews and relevant documents.

Internal validity evaluates whether the claims' evidence is complete and can avoid reporting spurious relationships as causal. Internal validity is concerned with the data analysis phase. Thus, I took measures that are considered by organizational research as useful to ensure internal validity: the conceptual frameworks, pattern matching, and theory triangulation (e.g., Eisenhardt 1989; Lincoln and Denzin 1994; Ravenswood 2011; Yin 2003). First, this study built three conceptual frameworks incorporating routine theory, dynamic capabilities theory, the notion of studying management control systems as a package, and levers of control theory. These theories and concepts bundle the research findings, describe and theorize the issues under research. Second, I compared the observed empirical findings and patterns with existing research findings. Third, I used institutional theories and the Actor-network theory to achieve theoretical triangulation.

Reliability demonstrates whether the research can be replicated with similar research findings; transparency and replication are the main elements. Although many qualitative researchers consider that reliability issues concerning measurements have no relevance in qualitative research (e.g., Stenbacka 2001), some researchers endorse the concept's dependability as reliable in qualitative research (Clonts 1992; Seale 1999). The reliability of qualitative research in this study is ensured through the appropriate research design and appropriate data collection and analysis techniques. These include the raw data, data reduction outcomes, and process notes. Also, the chain of evidence shows how the case study findings came from the collected data and from the original research questions.

Generalization "helps us to recognize connections between our own research findings and other concepts or phenomena that might not be evident at the study-specific, generalized level… [and] enables us to translate and communicate those findings across time and space so that their significance transcends the specificity of our own” (Parker and Northcott 2016, p. 1101). Danermark (2002) believes that methods for acquiring general knowledge and for examining the validity of generalizations are fundamental for all social science research. There is a distinction between statistical generalization and theoretical generalization; the latter deals with the generalization from empirical observations to theory, as opposed to the former that relates to population and draws inferences from data to a population. This research is concerned with exploring relationships and providing insights in order to develop theory (Saunders *et al.* 2009). As such, this research focused on achieving theoretical generalization (Parker and Northcott 2016). While the research findings relate to only one case study company, it is possible to infer through the theoretical generalization that, similarly, the post-upgrading of ERP and MCS changes may occur in other medium-sized Chinese manufacturing companies (Parker and Northcott 2016).

2.6 Organizational context—details of the case company

This section describes the case company’s institutional and industrial background, threats and advantages, digital infrastructure, ERP, and management control.[39]

2.6.1 SunPlants background – one of the leading mid-size manufacturers

As China’s national high-tech company, SunPlants is one of the largest production bases and exporters of the complete equipment (CE) for the petroleum industry. SunPlants' market, customer, R&D and operating characteristics are as follows:

Firstly, SunPlants achieved a higher market share in the industry. It has become a *Well-known Brand Enterprise* in China. With the leading R&D capability, excellent product performance and quality, and quality after-sales service, SunPlants’ products have been highly commended and favored by its customers in the last ten years. These products have been sold throughout China and successfully exported abroad. Over the recent five

[39] Note: the information below is socrced from the company’s website, annual report, and organizational profiles, etc.

years, SunPlants produces about one thousand and five hundred CE sets each year. Until 2020, more than two thousand sets of CEs have been exported in total. SunPlants' market share has been among the top ten worldwide in the last five years.

Second, SunPlants has maintained an excellent relationship with some leading petroleum organizations in China, such as Sinopec and PetroChina, due to its competitive advantages in the marketing network, superb product quality, and after-sales services. Such customer relationships enabled SunPlants to maintain its performance in the downturn period in 2014. During this period, the CE manufacturers generally faced reduced sales revenue and lagging sales returns. The well-maintained customer relationship has enabled SunPlants to avoid a massive loss over that period.

Thirdly, SunPlants can work well in developing new products, allowing for more diverse product categories and ordering sources. Since 2011, SunPlants has officially become an academician and expert innovation workstation. At that time, the government started to develop SunPlants as an innovation platform in this industry, fostering collaboration between SunPlants and the two Academies (i.e., Chinese Academy of Sciences and Chinese Academy of Engineering) in order to develop this industry. Later, SunPlants' R&D center was ranked as one of the strongest in China. Each year, it can develop three to five types of new products and over thirty technological transformations. Over the past five years, SunPlants has retained over 100 full-time employees in R&D. Five experts were being awarded *the National Expert Allowances*. SunPlants has obtained approximately 30 patents, some of which have filled global market and research gaps. At that time of the interview, SunPlants was still the only company to win the *National Innovation Fund Award* in this industry.

Fourth, however, SunPlants faces tremendous challenges and threats to its inventory due to the snowballing sale orders over recent years, but SunPlants still secures its competitive advantages through effective MCS. The company’s products are characterized as having a long business cycle from production to delivery to the customer’s acceptance. The snowballing sales orders, if not managed well, will lead to a high inventory level. SunPlants must maintain effective inventory control; otherwise, a large inventory may directly influence the company's working capital turnover and cash flow.

2.6.2 Digital infrastructure, ERP, and management control

In the past few years, the company has paid close attention to digital transformation. It has implemented the SAP ERP (see Diagram 2) since 2013. Prior to SAP ERP, SunPlants implemented a legacy ERP for more than a decade. Due to technical limitations and poor configuration, the former ERP failed to support SunPlants' digital transformation.

SunPlants used SAP to build the digitalization foundation, supplementing the comprehensive application of advanced digital technologies. The SunPlants CEO was directly involved in this project and in charge of this project, attempting to adopt SAP as an initial step towards its "three in one" goal.[40] SunPlants carried out this project to respond to reduced political support and continued its shift towards broader market orientation. In particular, SAP allows SunPlants to embark on a new journey of customer management, market development practices, and internal process optimization and improvement.

Through SAP, the company has integrated accounting and operations, technology and production, sales and production, thus improving overall management control. The SAP provides an open mechanism for product development, technology introduction and project cooperation, creating an opportunity for innovation and rapid change.

The company has adopted SAP to set up accounting control as a basis for promoting technology development, marketing and production management. Thereafter, SunPlants integrated quality controls, equipment management, personnel and administrative controls into one system. As a result, SunPlants updated the integration of finance and operations, technology and production, sales and production. It has attained a higher level of management control.

[40] i.e. intelligent management, intelligent production, and intelligent service

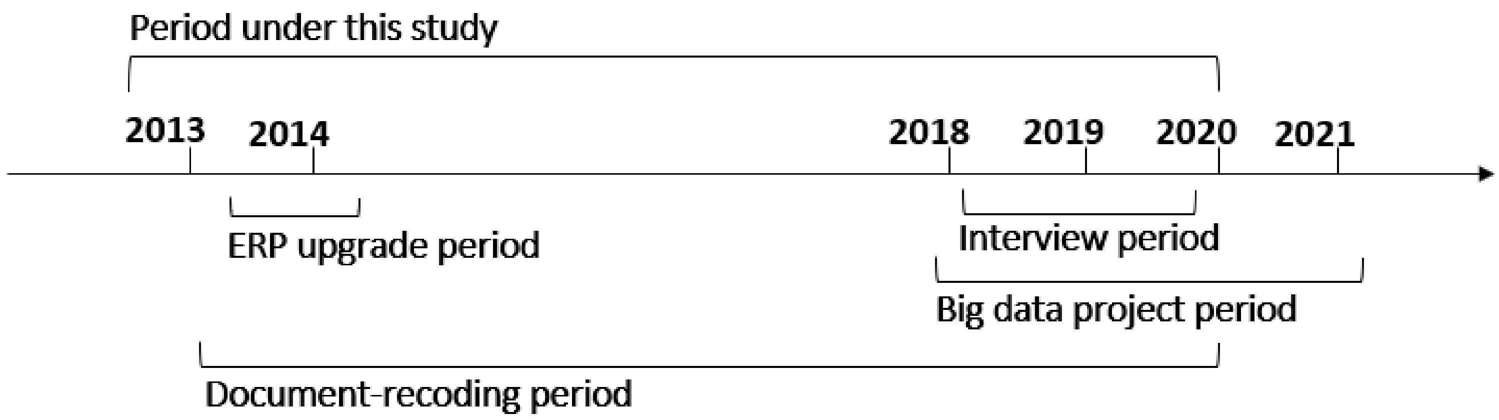
Having discussed how the research objectives are philosophically underpinned by social constructionism, how a single case is employed to investigate the research objectives, how data is sourced and analyzed to meet the research objectives, and how SunPlants competes in a hyper-competitive environment, the following three empirical chapters are used to present the research findings.

Diagram 2 Brief overview of the IS development at SunPlants

<table>
<tr><th></th><th colspan="2">Before 2013
Not-integrated</th><th>After 2013
Internal Integration</th></tr>
<tr><th></th><th colspan="2">Old ERPs</th><th>SAP</th></tr>
<tr><td rowspan="2">ERP</td><td>Accounting ERP</td><td>Logistics ERP</td><td rowspan="3">Sales and Delivery
Product lifecycle mgt
Material Management
Production planning
Financials
Control</td></tr>
<tr><td>Invoicing
GL Management
Fixed Assets Management
Financial Reporting</td><td>Material Management</td></tr>
<tr><td>Operation applications</td><td colspan="2">Sales Management System
R&D Management System</td></tr>
<tr><td>OA</td><td colspan="3">Workflow; Documents Distribution; Notification Distribution; Real-time Communication</td></tr>
<tr><td>CAS</td><td colspan="3">AutoCAD, SolidWorks, Pro/E, CAXA</td></tr>
</table>

GL: General Ledger
Mgt: Management
R&D: Research and Development
ERP: Enterprise Resource Planning
OA: Office Automation
CAS: Computer Aided Systems

Diagram 3 Timeframe



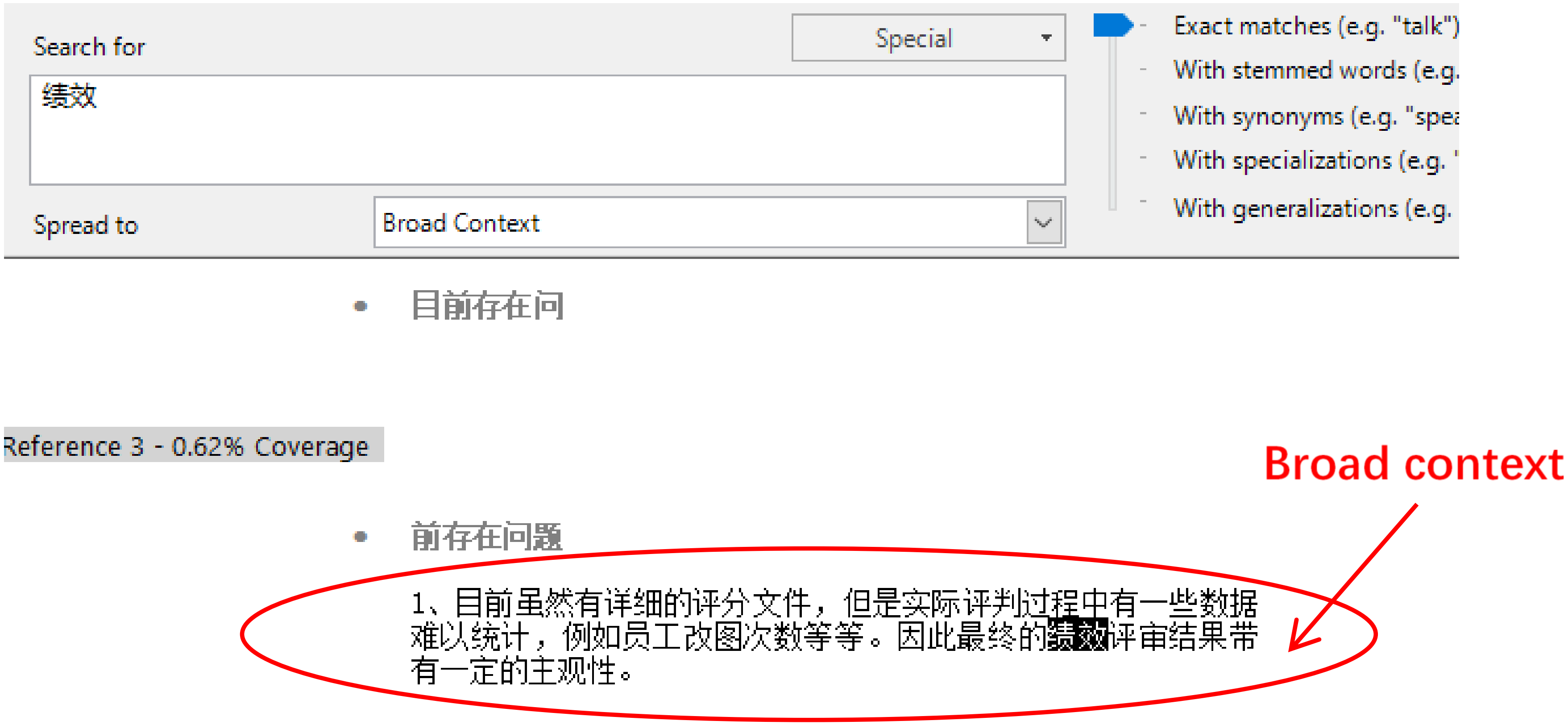
Note:
Period under this study: I focus on the period between March 2013 and October 2020 to understand SunPlants' ERP-based practice. During this period, the post-upgrading of ERP significantly affected SunPlants' management control and strategic management.
ERP upgrade period: SunPlants conducted its ERP upgrade, between March 2013 and June 2014.
Interview period: I took interviews for this thesis between January 2018 and August 2019.
Big data project period: SunPlants conducted its big data project between 2017 and 2021. The big data project is based on and works with SunPlants' ERP. The Big Data project is not at the core of this thesis but allows us to understand how the post-upgrade of ERP continues in SunPlants.
Document-recoding period: The internal documents that I sourced for studying the case of SunPlants were recorded between 2013 and 2020. Items recorded in internal documents took place between 2013 and 2020.

Table 1 Description of the documentary evidence

Type	SAP project investigation documents	Digitalization progression reports	IPO prospectus	Organizational profiles, online source
Description	• Produced by the vendor, through sixty-three interviewees in 2012 • Written as the project blueprint to guide and determine the steps, clarify the turning points, and set the progress of the entire project	• Produced by the Information department of SunPlants • Outline the information systems that are carried out by different departments, and uneven level of digital technology applications	• Produced by the IPO broker • Description of the SunPlants' business, and its strengths and strategy, within the last three years	• Produced by SunPlants • The company's background, history, and contexts
Access date	July 2018	July 2018	Dec 2018	July 2018

Note:
SAP project investigation documents are PICO, PIFI, PIMM, PIPL, PIPP, PISD. I used this naming convention in the quotation of the thesis.

Diagram 4 Example of coding broad context



Appendix 1 An interview scheme

	Position & name	Education	Interview dates		Position & name	Education	Interview dates
SunPlants				**Gosoft**			
1	SP Accounting manager	College	Mar 2019	22	Assistant CEO QY	University	Dec 2018; Jan 2019 May 2019 July 2019
2	SP CEO	University	Jan 2018, Apr 2019, May 2019, July 2019	23	Associated CEO QX	University	July 2014, Jun 2016, Feb 2017, Dec 2017, May 2018, June 2019, July 2019
3	SP CFO	Polytechnic school	Mar 2019	24	CEO QL	University	May 2018, Apr 2019, July 2019
4	SP Deputy head of R&D	University	Apr 2019	25	Consultant QT	University	Dec 2018, Feb 2019
5	SP Marketing central head	University	Mar 2019, Apr 2019, July 2019	26	Consultant QZ	University	Dec 2018, Feb 2019, July 2019
6	SP Marketing manager Dai	University	Aug 2019	27	Consultant LA	University	May 2018, June 2018, Dec 2018, Feb 2019
7	SP Marketing manager T	University	Aug 2019	28	Consultant LB	University	Feb 2019
8	SP Marketing staff G	University	Aug 2019	29	Consultant TA	University	Feb 2019
9	SP Marketing staffs H	University	Jan 2019	30	Consultant ZH	University	Feb 2019
10	SP Production manager L	University	Aug 2019	31	Consultant GZ	University	Feb 2019
11	SP Production manager W	University	May 2018, June 2018, Dec 2018, Jan 2019, May 2019, July 2019	32	Consultant QC	University	Feb 2019
12	SP Production manager Y	University	Aug 2019	33	Consultant RL	University	July 2014, Jane 2018
13	SP Production manager	University	Aug 2019	34	Consultant SX	University	Jan 2018

	Zh						
14	SP Production staff L	University	Aug 2019	35	Consultant SY	University	Jan 2018
15	SP Quality control staff	College	Feb 2019, Feb 2019	36	Consultant LW	University	Jan 2018
16	SP R&D manager H	University	Aug 2019	37	Consultant QB	University	Jan 2018
17	SP R&D manager X	University	Mar 2019	38	Engineer MW	University	May 2018
18	SP R&D manager Y	University	Mar 2019	39	Engineer MX	University	Jan 2019
19	SP R&D manager J	University	Aug 2019	40	Engineer RZ	University	July 2015
20	SP R&D staff O	University	Aug 2019	41	Engineer QJ	College	Dec 2018, Feb 2019, July 2019
21	SP R&D staff Q	University	Aug 2019	42	Engineer MJ	University	July 2018

Appendix 2 Interview questions

Demographic information:

1. What is the highest degree or level of school you have completed?
2. How did you get from the start of your career to your current role?

For vendor interviews:

1. What modules or functional areas do you specialize in?
2. What are your duties in the ERP and/or Clouding project?
3. How did you help SunPlants improve the ERP system?
4. Can you please talk about some real-life examples of your experience in the project(s)?

For SunPlants interviewees:

General questions:

I know your company is a leading company in this industry. Also, your company is an excellent example of digitalization transformation. I would like to ask you more questions concerning your company and the ERP (SAP) system:

1. What competition and challenges are evident in your company over the last five years?
2. What are the resources required by your department/function?
3. How the basic and core business processes and actions in your department are managed, and what is the role of ERP in managing them?
4. If your job requires or involves lots of data or information?
5. What are the types of data or information (e.g., operational, manufacturing, R&D, and administrative data or information)?
6. What are the main differences between the old ERP and SAP in this practice?

CRM practices:

I know your company has used SAP to make effective CRM and maintain a good relationship with your customer, but I still would like to ask you some questions concerning how they are reached in detail:

1. What are your company's main challenges in meeting customer needs and maintaining or boosting the market share?

2. How can your company effectively capture customers' needs, offer valid product options, and allocate resources to deliver the products?
3. How does the SAP ERP contribute to them, especially how accounting changes occur from the institutional, operational, and technical aspects?

Resource allocation and optimization:

I know your company has used SAP to make effective material resources allocation and optimization, but I still have some questions to ask you to deeper understand the running of the allocation and optimization process:

1. What are the main challenges your company faces in allocating material resources to produce products?
2. What specific functions are offered by SAP to address these challenges?
3. How can you work with these functions to improve decision-making and control in allocating material resources, especially how the decision-making and control techniques are configured to solve particular problems in various circumstances?

NPD practice:

I know SAP supports your company in developing a superior NPD practice, but I still have some questions concerning how:

1. What is the basic NPD process, especially which functions are mainly involved in this process?
2. Are these functions well-integrated (various processes merged without repeated actions) and well-coordinated (actions arranged into processes, but with some repeated actions)?
3. If yes, what are the main challenges and benefits of SAP-based decision-making and control that are performed for the integration or coordination?
4. How are SAP-based decision-making and control complemented in the integration or coordination process?

Appendix 3 Nodes created for each chapter

Free nodes (First stage)	**Tree nodes (Second stage)**	**Child nodes (Third stage)**
CRM actions (First empirical chapter)	Connection	• Information defect • Technical defect • New artifacts
	Integration	• Actions and behaviors • Financial and non-financial • Intra-departmental • Inter-departmental
	Operational advantage	• Efficiency • Ostensive aspects • Other emergent problems
	Strategic advantages	• Sense • Seize • Reconfigure • Other emergent problems
Material-related actions (Second empirical chapter)	MCS reconfiguration	• Functions in resources
		• Functions in actions
		• Forms
	Flexibility	• Structural • Functional
	Strategic advantages	• Resource addition • Resource deletion • Resource movement • Other emergent problems
Production and R&D-related actions (Third empirical chapter)	Diagnostic lever	• ERP and progress monitoring • Performance measurement and compensation/rewarding
	Interactive lever	• ERP formal communication and interactions • Informal communication and interactions

	Diagnostic and interactive levers	• Resources and activities integration • Asset orchestration • Accountability problem
	Senior management involvement	• Diagnostic use • Interactive use • Diagnostic and interactive uses
	Strategic advantages	• Structuring actions and resources • Bundling actions and resources • Leveraging actions and resources • Other emergent problems

Appendix 4 Chain of evidence

Chain of evidence of Chapter 3			
Theme based on concepts	Child codes related	Exemplary interview quotes	Summary of the findings
The ostensive aspect related to MC	• Financial & non-financial • Information defect	"[The collection of] accounts receivable (i.e., invoicing by schedule, receivables in advance) and payment (i.e., settlement) needs to be linked with the [payment] collection plan"; (PISD 4.14.3) "[The system needs] to actualize the consolidated statistical analysis report between multiple sub-companies, such as the accounts receivable of the companies". (PICO 5.1.1) "Data entry [tasks] has not yet been evaluated to a large degree (this means that before SAP, data entry was not evaluated)… This is because the common nature of [Chinese] SMEs are characterized as the "Rule of Man"… [whereby] the controller requires that data has to be entered before the end of the month when the financial department makes the reconciliation…" (Quality Control staff)	Management control changes are observed to occur in the ostensive aspect. In this aspect, the changes are manifest in the improved connection of various ostensive aspects and improved action pattern abstraction ability.
The performative aspect related to CRM practices	• Actions and behaviors • Efficiency	"About 100 accountants were involved in finalizing the financial reports, but that number has been reduced by more than half." (SunPlants Accounting Manager) "There are many departments involved in the sales contract approval process, and the cycle is rather long. It usually takes two days for a contract to complete the approval. The maximum approval time can be up to one week. At present, each sales contract requires approval, and the contract review process is not uniform, and there is no unified interface… Moreover, the approval linkage and departments involved in each set of approval processes are also different." (PISD 4.14.1.1) "After having been approved by the R&D center, the spare parts dispatched with the host machine are updated from the PLM module to the sales order…" (PISD 4.14.3.2)	Management control changes are observed to occur in the performative aspect. In this aspect, the changes are manifest in improved bottom penetration ability of management control practices with less accounting labours and errors.
The artifacts related to CRM practices	• Technical defect • New artifacts	"The SAP system is rather compelling and ideal… especially in the context where more than 1,000 people are working on it… SAP facilitates the planning function for managing rather complex processes…" (The deputy head of the R&D department) "In the past, we used Excel to integrate the set of accounts and information, and it needs lots of human resources to make the	Management control changes are observed to occur in the artifact aspect. In this aspect, the changes are manifest in enhanced information connections to reflect relatively complete action patterns.

		recording and statistics of the information…" (Financial Manager Y) "I really need to view the monetary amount of production auxiliary consumed and the unit price of the auxiliary materials….so that I could decide on the use of some auxiliary materials in some circumstances to cope with emerging changes, such as material substitutions due to the shortage of some materials (Production Manager L)	
The incorporation of them in CRM practices	• Intra-departmental • Inter-departmental	"The amount of data and required documents are huge, but the [information] processing efficiency is quite low [in the old systems]; [moreover], there are many financial indicators to be manually calculated; many reports require manual registration, which is time-consuming and inefficient". (PICO 5.1.1) "[Before the use of SAP], the [degree] of the actual application of ERP and other information systems was not high, because [the company] did not have a higher standard in the operation of actions. For example, a world-leading company in the industry would strictly do an action in five steps, but the company (SunPlants) only did one or two steps at most times…" (Consultant ZH from the vendor "At present [at the old ERP time], the sales cost carry-over ledger (accounting system) used by the sales team is not integrated with the existing operational (ERP) systems. There are information islands between the systems... The sales orders [of SunPlants] have not been completely entered into the sales cost carry-over ledger (accounting system). At present, the engineering project department and the parts department have no access to the sales cost carry-over ledger (accounting system) to manage the sales business, and the sales order needs to be managed outside the system. The sales cost carry-over ledger (accounting system) used by the sales team only manages the sales order information and fails to integrate with the following delivery documents and sales billing." (PISD 4.14.1.1) (SAP solved these problems) "SAP imposes tighter rules on the operation line. It is much more elaborate… That means it starts from the very bottom of the operation…" (Accounting Manager)	ERP-based management control changes and related impacts lie within the constant connections between the artifacts that handle organizational actions and, thus, effectively integrate principles, rules, standards, programs, and procedures that underpin organizational activities of various kinds.
ERP-based management control in the sensing routine	• Sense	"This sort of information can enable the company to boost its sales revenue… The profit of complete sets of equipment is not too high due to competition, but the spare [of the equipment] that is used for after-sales service is relatively profitable, as most of the spares are customized and non-standardized…. The current revenue of this type of business is only 30 million Yuan per year. However,	Although SAP enables common artifacts, SAP does not directly support managers in developing connectivity to the external parties to sense changes and opportunities

		the actual market is about 120 million Yuan… Nonetheless, SunPlants cannot transfer this opportunity, but they are attempting to achieve it by advancing its information system… Advancing the information system not only helps to capture the opportunity but also helps them allocate resources to execute the production…” (Senior Manager Y of the vendor)	
ERP-based management control in the seizing routine	• Seize	“[In the old ERP], the contract does not include the unit price, additional charge, packing expenses, delivery expenses, and unloading charge, and the pricing details about a single order are usually not available. This is because the system is unable to offer such details to include in the contract.” (PISD 3.5.1.4) “Before the adoption of SAP, sales teams relied upon their own “experience” to evaluate the profitability of an order, irrespective of comparing the profitability among identical orders… Most of the less profitable orders were accepted, and thus more profitable orders were influenced, and most orders were delayed…” (Production Manager W)	SAP provided numerous managerial artifacts to illustrate how to rapidly seize a business opportunity from the contract because the way to specify the actions was well-specified and inscribed in MCS. Then, the effective use of MCS kept the seizing routine to develop over time continuously.
ERP-based management control in the reconfiguring artifacts	• Reconfigure	“In the past, accounting staff have tried their best to calculate the total price of the final product, and it was difficult to detail the consumption of the material, the labor and the overheads [associated with one order].” (SP CFO) “[In the old ERP] the execution of the sales order needs to be judged through external communication and human control…” (PISD 4.14.1)	The contracting practice becomes supportive of the reconfiguring routine. It helps MCS to make better plans to specify actions in order to fit various circumstances, with clear milestones that need to be met accurately.
Chain of evidence of Chapter 4			
Theme based on concepts	**Child codes related**	**Exemplary interview quotes**	**Summary of the findings**
ERP-based management control configuration with little management control interdependency	• Functions in resources/actions • Structural/Functional (in)flexibility	“With the library, the company is capable of breaking the bottleneck in production and product development [in terms the selection of single material resources].” (The R&D manager X) “SAP with the library significantly facilitates our work efficiency. For example, the inquiry function [for any single resources and activities] becomes powerful in the CMS process by using “where used list.” (R&D Manager L)	The basic form to describe how two or three management control practices work interdependently to solve problems that occur in the movement of single resources
ERP-based management control configuration with moderate management control interdependency	• Functions in resources/actions • Structural/Functional (in)flexibility	“[The SAP system] can distinguish the purchase [activities] of different raw materials, tracking the final use of the purchased materials, and tracing the finished products after-sales. Batch number management is enabled for raw material purchase receipt and storage, production release, finished product storage, sales and delivery, etc.. Subsequently, follow-up material and finished	The intermediate form describes how three or four management control practices work interdependently to solve problems that occur in the movement of a group of resources

		product quality tracking and control are enabled. When finished products are put into storage, all batch numbers and quality certification documents can be analyzed and displayed in the unique interface". (PIMM 3.3.1)	
ERP-based management control configuration with extensive management control interdependency	• Functions in resources/actions • Structural/Functional (in)flexibility	"Although BOM cannot correctly represent the management control of the production line in the company, it can reflect the standardization level of the company, and a good BOM can enhance the material commonality… In this way, the diversification of material procurement is developed… So, it can be said, BOM also represents the cost performance of product design, especially the material substitutability, including substitution among different types of materials, among different brands, among different sizes…Also, BOM represents the company's ability to resolve the conflict between the engineering department and production department because the CMS or substitution is a compromise process in nature…If BOM takes the situation where substations are required into account, conflicts can be avoided or resolved faster…" (Production manager W)	The advanced form describes how four or five management control practices work interdependently to solve problems that occur in the changes that emerge in the movement of a group of resources
ERP-based management control configuration form supporting resource reconfiguration of single resources and activities	• Resource addition/deletion/movement	"[The] SAP system is rather compelling and is ideal for managing R&D with complex processes, especially for the context where there are more than 1,000 people engaged in production and R&D activities… SAP facilitates the planning function for managing rather complex activities…" (The Deputy Head of the R&D Department) "SAP routinizes most activities, which is much more convenient… It is user-friendly and standardizes and solidifies the process and activities, which eliminates unauthorized and frequent modifications in the process and data infrastructure… We can finalize the design much faster than before." (R&D Manager H)	SAP-based MC practices are more effective in allocating and reconfiguring material resources appropriately and promoting the extensive use of particular material resources into more comprehensive actions and product ranges.
ERP-based management control configuration form supporting resource reconfiguration of various group of resources and activities	• Resource addition/deletion/movement	"After the subsequent batches are managed through the [SAP] system, it will effectively help to enable the follow-up traceability… The [SAP] system supports the batch management for the raw materials… can accurately record the corresponding batch number when entering the warehouse and leaving the warehouse…The system supports batch number management for finished products and key components, facilitating follow-up quality traceability". (PIMM 3.3.2) "The aim of using ERP is simplifying the complicated things (e.g., data and processes), then we are allowed to standardize and normalize the processes, and we have the opportunity to digitalize and process them." (Marketing Manager K)	SAP-based MC practices provide an adequately designed organizational structure that makes the flows of multiple resource groups tracible and the flows of multiple resource groups run with well-structured data and information.

ERP-based management control configuration form supporting resource reconfiguration of changes of any group of resources and activities	• Resource addition/deletion/movement	"The execution of BOMs is a compromise process in nature…Especially between the R&D department and the production department… Improper BOMs lead to conflicts between them… It incurs huge maintenance costs… Some temporary substitutes or short-term substitutes were used as long-term substitutes in the production line, which disturbs the R&D department… The update of the BOMs is a huge project… For example, a supplier has stopped the supply of some old products (raw materials), and new products (raw materials) are being supplied "temporarily" or "shortly" … The new ones have replaced the old ones because the old ones are no longer in use… The update of the BOMs is not merely the responsibility of the R&D and production departments…The BOMs were not updated until the adoption of SAP…" (Production manager W) (Note: SAP offered a solution to improve the way to cope with these problems)	SAP-based MC practices promote the firm to maintain transparency and flexibility of the internal process and the generative mechanisms to produce accounting numbers and management information that enable long-term competitive advantages.
Chain of evidence of Chapter 5			
Theme based on concepts	Child codes related	Exemplary interview quotes	Summary of the findings
ERP-based diagnostic lever	• ERP and progress monitoring • Performance measurement and compensation/rewarding • Senior management involvement in diagnostic use	"[SAP has made us] to get used to making order notes when processing orders and plans…The notes make more details of an order via unstandardized information." (Production Manager Zh) "No one is willing to use ERP unless it is mandatory." (The Deputy Head of the R&D Institute) "Currently, the machine data (such as the machine tool effective running time, shift, etc.) is manually recorded, and the data is not accurate… (PIPP 2.1.2) There is no systematic basis for [production] capability assessment. It can only be done by human experience… (PIPP 2.1.2) ERP is expected to provide new product trial production progress report and output report and working time report." (PIPP 2.2.5) "… they believed that ERP weakened their authority because they and their departments are becoming visible." (SunPlants' Marketing Central Head)	Quality data and information that are produced by SAP can help in developing an effective diagnostic lever in structuring the resources. Also, the supply of quality data and information is not sufficient; considerable managerial efforts are needed to transform the supply of quality data and information in order to become a factor in behaviour motivation.
ERP-based interactive lever	• ERP formal communication and interactions • Informal communication and interactions	"Most business communication is communicated through workflow… The subsequent workflow can be configured flexibly, and the node can be set according to the position". (PIPP 2.1.1) "I need the information to trace the progress of the order, and report it to clients or my leader (senior managers) … Before SAP, R&D and production departments mainly collected and calculated	The interactive lever that was constructed by informal communication tools provides managers with timely information exchanges and the chance to discuss managerial and operational

		the data and information manually, which was associated with lots of errors and sent to me very slowly…" (SP Marketing Manager Dai)	information. Subsequently, managers retrieved the relevant data and information from SAP for decision-making, then translated their decisions into the plan or other formal forms via SAP.
ERP-based complementarities between the diagnostic lever and interactive lever	• Resources and activities integration • Senior management involvement in diagnostic and interactive uses	"Communication via SAP takes much [more] time… not merely because of the technical factors… for example, sometimes one key person [within the communication network] is not in the company…" (R&D SP CFO) "We used such [an informal communication] tool (e.g., Dingding, Wechat, and RealTimeeXchange) to communicate with the R&D and sale departments when there were multiple sizes and various materials to select and decide upon". (Production Staff L)	SAP enabled SunPlants to develop the interactive lever by offering relatively consistent semantics and connotations. The managers used numbers or codes to materialize open dialogue, an ideas exchange, and frequent feedback, which facilitated collective decisions regarding possible opportunities.
The control lever in the structuring routine	• Structuring actions and resources	"SAP offers more information for decision-making and controls… for example, it helped make the organizational structure and business process to change, but it did not create the change…" (SunPlants' Marketing Central Head)	The SAP-based control levers build the interconnectedness of MCS, actors, and technologies in the structuring routine through improving shop floor progress monitoring, performance evaluation systems, and behavior motivation. However, although the shop-floor rules, principles, and procedures became computerized, shop floor production staff were unwilling to enter their performance data. Subsequently, the monitoring function initially failed to be digitalized.
The control lever in the bundling routine	• Bundling actions and resources	"SAP facilitates coordination between different departments… We have a huge reliance on SAP… For example, when the source information is accurate, we can produce the plan directly… In the past, the old ERP systems merely recorded data and information but did not offer feedback…" (Production Manager L)	SAP-based complementary use of diagnostic and interactive levers grouped organizational resources together for more effective handling in order to develop capabilities that gave SunPlants a competitive advantage. This SAP-based control lever built the bundling routine through three main stages, which are the one stabilizing managerial attention, the

			one diffusing organizational goals in their explicit form, and the one enriching new ideas and product development.
The control lever in the leveraging routine	• Leveraging actions and resources	"[When compared with the old ERP], the SAP system is rather compelling and is ideal for managing R&D with complex processes, especially for the context where there are more than 1,000 people engaged in production and R&D activities. SAP keeps the R&D actions in a routine, preventing developers from focusing too much on their personal situations and ignoring the entire progress of the project". (The Deputy Head of the R&D department) "Dealing with the sales orders was rather time-consuming with the old ERP … The production department was always waiting for us… SAP helps us avoid lots of errors made by manual order processing." (SP Marketing Manager Dai) "[Orchestration] is not taking a bunch of data and analyzing them all together…[SAP] supports the translation of business into data by people". (GoSoft Associated CEO QX)	SAP-based complementary use of diagnostic and interactive levers continued to leverage the orchestration process. The complementary use of the two levers leads to the dynamic coordination between the customer demands, product, and production. This process is characterized by the mutual translation of business and data, and reflective actors.

Chapter 3. Sensing, seizing, and reconfiguring: what ERP can and cannot do for management control systems

3.1 Introduction

The first empirical chapter investigates the impact of the post-upgrading of ERP on CRM practice changes and discovers possible ways of using ERP-based MCS to develop three different DC routines (i.e., sensing routine, seizing routine, and reconfiguring routine).

These three DC routines work together to describe how a company competes within increasingly dynamic conditions by modifying a company's product or service offerings, processes for generating and delivering a product or service, or extending customer markets (e.g., Beske *et al.* 2014; Helfat *et al.* 2007; Iansiti and MacCormack 1996; Teece *et al.* 1997; Winter 2003). The sensing routine describes how a company explores uncharted areas, identifying opportunities and risks critical to survival and development; the seizing routine describes how the company minimizes the time gap between new product development ideas and product delivery; the reconfiguring routine creates new value-in-use to materialize the enhancement of customer relations through addition, deletion, or movement of resources (e.g., Alinaghian and Razmdoost 2017; Huang *et al.* 2017; Karim 2006; Karim and Mitchell 2004; Yeow *et al.* 2018). In addition, each of these three routines should be "a repetitive, recognizable pattern of interdependent actions, involving multiple actors" (Feldman and Pentland 2003, p. 96). When one or more of these conditions is absent, then the phenomenon fails the test of being a routine.

Some existing research suggests that ERP-based MCS practice could help to develop these routines. First, ERP is built based on the premise of constructing a closed-loop leading to effective action repetition (Jacobs 2007; McGaughey and Gunasekaran 2007; Muscatello *et al.* 2003; Shi and Halpin 2003; Umble *et al.* 2003) and routinization (Pishdad and Haider 2013; Rajagopal 2002). ERP helps routinize organizational actions into such three routines by providing seamless integration of processes across functional areas with improved workflow (e.g., Akkermans *et al.* 2003; Wortmann 1998), standardization of various business practices (Koch 2001), and access to real-time data (Quattrone and Hopper 2005). Second, MCS helps to recognize action patterns and routines. MCS practices guide, account for, and refer to organizational actions by producing principles, rules, standards, programs, and procedures representing the organizational routines (Feldman and Pentland 2003). Third, MCS and ERP work together to create "an unending process" of MCS integration (Dechow and Mouritsen 2005, p. 691), leading to better decision-making and control (Bhimani and Willcocks 2014). The integration manifests as the decentralization and dispersion of the management accounting function, where management accounting tasks are increasingly performed in other functions of a company as a whole (e.g., Caglio 2003; Malmi 2001; Rom and Rohde 2007; Scapens and Jazayeri 2003), routinizing more value-creating actions (e.g., Lai *et al.* 2016; Scapens and Jazayeri 2003), and leading to positive performance contributions (e.g., Chapman and Kihn 2009; Nicolaou and Bhattacharya 2006; Velcu 2007).

However, little is known about how the ERP-based MCS develops these three DC routines in concrete terms. The emergence of China's rapid digitalization-based transformation makes this research gap interesting and important. Although existing MCS-ERP studies have recognized the importance of ERP on MCS integration leading to routinization, they are based on the premise that ERP enables data and process standardization to develop MCS integration and organizational routine. Over recent years, the increasingly dynamic external changes may break the premise of data and process standardization (e.g., Braganza *et al.* 2017; Teece 2009; Yeow *et al.* 2018). This break would disrupt routinization because actions are not easily defined as "repetitive, recognizable patterns of interdependent actions, carried out by multiple actors"

(Feldman and Pentland 2003). How digital technologies promote DC has become an interesting and important issue in strategic literature (e.g., Amit and Han 2017; Cenamor *et al.* 2017; Eller *et al.* 2020; Karimi and Walter 2015; Warner and Wäger 2019).

This chapter focuses on the impact of the post-upgrading of ERP on CRM practice. Presumably, the post-upgrading of ERP is more likely to involve CRM changes in the digitalization age (e.g., Crittenden *et al.* 2019; Draijer 2004; Kale 2014; Kotarba 2017; Legner *et al.* 2017). The changes might be related to sensing, seizing, and reconfiguring routines, directly affecting the customer base and product or service performance. CRM practices involve customer-related actions (e.g., customer service, order management, invoice-billing, or sales and marketing automation and management). These actions are important in MCS practices to make inter-company linkages (e.g., Foster and Gupta 1994; Helgesen 2007; Lind and Strömsten 2006; Roslender and Hart 2010; Wouters and Kirchberger 2015; Zineldin 2005), leading to strategic capabilities (Jancic and Zabkar 2002; Kohtamäki *et al.* 2019; Morgan and Hunt 1994; Paschou *et al.* 2020; Vogt 2008).

A wide range of MCS techniques have been developed to deal with these actions, including customer profitability analysis (Guilding and McManus 2002; Hart and Roselender 2001), the Balanced Scorecard (Busco and Quattrone 2015; Malmi 2001; Wiersma 2009), and several strategic management accounting approaches (Roslender and Hart 2002). CRM also relies on “the capability-oriented exploration of data” (Dechow *et al.* 2006, p. 631), which is more concerned about developing relationships (Dechow *et al.* 2006; Zineldin 2005), increasing the customer base (Zineldin 2005), and increasing analytical effort to improve product or service performance and availability (Ahrens and Mollona 2007). However, environmental dynamics in the digitalization age would induce unexpected complexities in CRM practices, such as more unstructured data, changing customer behavior patterns, and surging new customer needs (e.g., Anshari *et al.* 2019; Malthouse *et al.* 2013; Martens *et al.* 2016).

I apply the three concepts of Feldman and Pentland's (2003) theory of organizational routine (TOOR) to investigate the CRM change and the change's impact on DC: the ostensive aspect of routine (i.e., the abstract or schematic pattern of actions); the performative aspect of routine (i.e., the specific instances of action, actors, time and place); and artifacts (i.e., the means of carrying out the routine, including written rules and digitally codified procedures, software and computers, and general physical setting).

The theory and concepts fit the objectives of this chapter because both MCS and DC are in fact organizational routines, but they represent different aspects (e.g., Burns and Scapens 2000; Dosi *et al.* 2000; Pentland *et al.* 2012). Furthermore, TOOR theorizes the role of ERP in organizational routine, as actors and artifacts carry out real routines. Additionally, the three TOOR concepts work together to reveal the micro-foundations of the change from three different aspects (i.e., the ostensive, the performative, and the artifacts). Finally, the movement from the ostensive aspects to the performative aspects can indeed be interpreted as MCS practices, such as "guiding, accounting, and referring" organizational actions (Feldman and Pentland 2003, p. 106). These three concepts offer a starting point further to understand the relation between ERP, MCS, and DC.

Drawing on the organizational routine theory, this chapter shows that the ERP-based MCS changes may appear as three ways of improvement at the micro-foundation level: first, the information connection at the artifact aspect; second, the action pattern abstraction at the ostensive aspect; and third, the bottom penetration at the performative aspect. ERP-based MCS changes appear as the incorporation of three terms: ostensive aspects, performative aspects, and various artifacts. The changes that occur at the micro-foundation level directly promote CRM practices to develop the seizing and reconfiguring routines but not the sensing routine. The changes also confirm the essential interdependencies between (digital) technologies and MCS (Dechow and Mouritsen 2005).

The chapter makes the following contributions. First, it contributes to the MCS-ERP literature by revealing and tracing how the three major ERP upgrade-based MCS changes have been created (i.e., through enhanced information connection at the artifact aspect, action pattern abstraction at the ostensive aspect, and bottom penetration at the performative aspect). The impact of the post-upgrading of ERP on accounting practices has been recognized (Wagner *et al.* 2011), however the existing MCS-ERP literature might have no opportunity to observe the post-upgrading of ERP. This chapter bridges this research gap by focusing on the post-upgrading of ERP.

The chapter also highlights that the ERP upgrade-based MCS changes may occur simultaneously at various levels (i.e., the ostensive aspect, performative aspect, and the artifacts aspect), instead of appearing at the level of information or physical systems (Dechow and Mouritsen 2005; Quattrone and Hopper 2005) in the initial ERP adoption. Knowledge about the three changes could suggest future MCS-ERP studies, especially those concerning the post-upgrading of ERP, focusing on how MCS changes occur simultaneously at various abstract and concrete levels.

Second, the three constructs developed in this chapter (i.e., accounting and operational artifacts, and common artifacts) might theoretically contribute to the organizational routine theory. These three concepts respond to recent calls to build connections between capabilities and organizational routine (e.g., Howard-Grenville and Rerup 2016; Parmigiani and Howard-Grenville 2011).

Accounting and operational artifacts represent specific artifacts that are produced in different operational (performative) areas. In this chapter, they are characterized as having different functions, posting/update times, and connections (i.e., widely connected, or isolated). Common artifacts show how specific artifacts are further connected, transformed, and maintained (common artifacts) for effective decision-making and control practices in three core strategic routines (e.g., sensing, seizing, and reconfiguring routines). These three constructs suggest possible future organizational routine theory-based studies: accounting and operational artifacts could work together to promote and navigate the challenging process of creating and replicating new routines across multiple functional areas within a company.

Third, this chapter contributes to understanding the practical ways of developing DC by exploring how the impact of the post-upgrading of ERP on CRM and MCS differs in three different DC routines. Researchers have recognized the importance of studying the practical ways of developing DC to compete in increasingly dynamic environments (e.g., Ambrosini and Bowman 2009; Dixon *et al.* 2014; Salvato and Vassolo 2018; Zahra *et al.* 2006). I demonstrate how the specific benefits (e.g., the broader physical memory space for transaction recording) involved in the post-upgrading of ERP improve the concrete accounting practices (e.g., accounts receivable) of CRM in order to facilitate specific customer-related actions leading to different DC routines. This informs the senior managers, who may not have had satisfactory ERP experiences, to notice that ERP per se might not promote accounting practices. Accounting practices could therefore be promoted by ERP when specific ERP functions and modules are properly selected and implemented.

Furthermore, I reveal the critical role of the flexible use of other digital artifacts producing engineering data to facilitate ERP and MCS to the three DC routines. This knowledge suggests to those managers who wish to make the business-accounting integration that this integration is not merely about merging data. It is also concerned with the use of physical-digital technologies to make extensive data collection, extraction and connection, and business process reduction.

The paper is organized as follows. The next section (Section 3.2) describes how the existing literature examines ERP-based MCS change and its possible impact on capability levels. The third section (Section 3.3) explores how the conceptual framework is constructed through the theory of organizational routine. Section 3.4 briefly introduces SunPlants' CRM practices, before section 3.5 presents the case findings by deconstructing the routine, focusing on the routine, and rebuilding it, and Section 3.6 discusses the relationship between ERP and MCS that occur at the routine and capability levels. The final section (Section 3.7) concludes with a summary of this research, its contributions, and its limitations.

3.2 Literature review

This section describes two research streams concerning MCS-ERP-strategy issues. The first stream embraces the impact of ERP on MCS. The second stream perceives the impact of ERP-based MCS on organizational capabilities. The final section provides a discussion of MCS-ERP-strategy literature, identifying the research gap within MCS-ERP-strategy issues, and suggesting a possible way to bridge the research gap.

3.2.1 *The general impact of ERP on MCS change*

Existing MCS-ERP studies offer a general understanding of ERP-based MCS change in three ways: first, the motivation of ERP adoption relevant to MCS; second, problems that arose during the adoption process; and third, ERP's impact on MCS.

First, the literature identifies various motivations that drive the change. Granlund and Malmi (2002) consider that ERP motivates companies to re-institutionalize MCS practices to solve problems from institutional perspectives. Specifically, Scapens and Jazayeri (2003) indicate that companies use ERP to centralize control in the face of increased competition and globalization. Scapens and Jazayeri (2003, pp. 222-223) point out three main changes in MCS resulting from ERP adoption: eliminating redundant jobs, more financial responsibilities to be taken by line managers, and changing the role of the management accountant.[41] Drawing on the Actor-network theory, Dechow and Mouritsen (2005) and Quattrone and Hopper (2005) view ERP as a means by which to offer an integration function for controls. The integration function helps to achieve the integration of diverse MCS practices and then creates the intended strategy to implement this successfully. Accordingly, the existing MCS-ERP literature suggests that ERP adoption motivations in relation to MCS lie within promoting the

[41] "First, many of the jobs which were previously done by cost clerks and other accounting personnel are no longer necessary - they are now either done by SAP itself, or are centralized in a shared services centre……Second, line managers are increasingly taking more responsibility for the financial aspects of their own activities, and as a result accountants are responsible for the systems, but not for the contents of the final reports……Third, the above changes have created both the need and the space for management accountants to play a more creative role within management teams."

enactment of rules, standards, principles, control, and centralization.

Second, the literature also documents various problems arising from the change process. Two main types of problems are dominant in the interaction process: human-made (social) problems; and technical problems. The human-made (social) problems relate to resistance to using the ERP system (Dechow and Mouritsen 2005),[42] the different intentions of different actors using ERP and MCS (Hyvönen *et al.* 2008), and managers' ideology towards the use of MCS (Teittinen *et al.* 2013). Many technical problems are associated with the non-specifical design of ERP for MCS (Granlund and Malmi 2002), the simple conversion of MCS into the new ERP system (Dechow and Mouritsen 2005), and the lack of resources to support the implementation (Hyvönen *et al.* 2008; Teittinen *et al.* 2013). Wagner *et al.* (2011) imply that the problems should be socio-material in nature, as ERP-based MCS involves an interconnected process of accounting, technologies, people, and context. Accordingly, both social and technical problems will arise during the ERP adoption process. There is also a need to consider the interdependent impact of both social and technical problems (i.e., socio-material problems).

Third, regarding the outcomes or performance effects of ERP on MCS, the existing research has demonstrated that ERP has not led to radical changes to MCS, although the change does bring about positive effects to MCS and companies. One of the most obvious changes is the reduction of routine accounting tasks and the changing role of management accountants (Granlund and Malmi 2002; Quattrone and Hopper 2005; Scapens and Jazayeri 2003). Some studies also focus on how MCS influences ERP's effects on companies' financial performance (Chapman and Kihn 2009; Kallunki *et al.* 2011), market performance (Chapman and Kihn 2009), and social responsibility (Chapman and Kihn 2009), and other non-financial performance (Kallunki *et al.* 2011).[43] Through studying ICT and MCS, Xiao *et al.* (2011) imply how ERP influences

[42] Nevertheless, Granlund and Malmi (2002) suggest that it might need several years to solve this problem because ERP was not specifically designed for any MCS techniques.

[43] The authors measure non-financial performance through materials efficiency variance, ratio of good

MCS's performance effect, such as cost efficiency, customer satisfaction, employee morale, job satisfaction and commitment, on-time delivery to customers, innovativeness, and continuous improvement. The literature shows that ERP affects the performance effect of MCS in multiple ways, and furthermore, ERP and MCS are mutually affected.

However, although existing MCS-ERP studies produce an overview of how ERP and MCS can work together to achieve operational efficiency and critical competencies, the understandings are too general to understand the specific strategic issues of the relationship between ERP and MCS. Little is known about how they contribute to strategic changes that are very important in management accounting research. It is vital to focus on how ERP and MCS work at the strategic capability level (Henri 2006). Although existing studies show that the relationship between MCS and ERP is neither technical nor social, existing studies lack a framework by which to integrate technical and social issues in conjunction with their organizational and strategic impacts.[44]

3.2.2 MCS and organizational capabilities

This section uses organizational capabilities to represent the long-term and sustainable organizational performance rather than the short-term performance that existing MCS-ERP studies have recognized.

ERP-based MCS is both a type of organizational capability (e.g., Henri 2006; Mundy 2010; Simons 1990; Widener 2007; Winter 2003) and a changing force of other organizational capabilities (e.g., Felin *et al.* 2012; Simons 1994; Winter 1995). The

output to total output at each production process, manufacturing lead time, rate of material scrap loss, labor efficiency variance, number of new patents, number of new products launches, time-to-*market* new products, employee satisfaction, personnel development, workplace relations, employee health and safety, increase in market share, customer response time, on-time delivery, number of customers complains, number of warranty claims, customer satisfaction, percentage of shipments returned due to poor quality, number of overdue deliveries, customer retention, acquisition of new customers.

[44] Although Wagner et al. (2011) adopt a socio-material perspective, this perspective did not attend to organizational impact issues, so do those who adopt actor-network theory (e.g., Dechow and Mouritsen 2005)

integral role of MCS manifests in organizational capabilities in three particular ways, namely, MCS per se as organizational capabilities, MCS as the changing force of organizational capabilities, and the mediators between MCS and DC.

First, MCS per se is a type of organizational capability. Soin *et al.* (2002) find that ABC is developed as an organizational capability, with its implementation associated with the displacement/establishment of the capability. Newey and Zahra (2009) reveal that product portfolio planning per se acts as a form of DC reconfiguring operating capabilities to cope with the exogenous shocks. Peters *et al.* (2019) find that budgeting, forecasting, and results-reporting practices follow the salient tenets of the DC logic. The authors clarify the beneficial roles of formal cybernetic control systems through creating knowledge for sensing, seizing, and business model reconfiguring (to manage strategic business change) capabilities. Ojha *et al.* (2020) find that the dynamic strategic planning manifests as the DC logic to positively influence financial performance through operational capabilities. In other words, MCS is not merely a type of operational capabilities, but a type of strategic capability.

Second, MCS improves organizational capabilities. Davila (2000) finds that formal controls, particularly in setting non-financial measures, may positively affect NPD performance, which is a core organizational capability. Henri (2006) reveals that the use of MCS can contribute to four capabilities leading to strategic choices, including market orientation, entrepreneurship, innovativeness, and organizational learning. Both of the studies of Frow *et al.* (2010) and Chenhall and Moers (2015) reveal that MCS supports capability building in innovative settings. The findings of Pešalj et al. (2018) highlight the importance of keeping the active and continuous use of all four controls (i.e., the interactive and diagnostic controls, and the belief and boundary systems) to overcome a lack of managerial processes and capabilities. MCS also improves capabilities in conjunction with trust-building (Pablo *et al.* 2007) and accountability (Parmigiani and Howard-Grenville 2011) in order to influence organizational performance. Accordingly, MCS is involved in other concrete strategic actions and is integral to the strategic actions.

Third, the relationship between DC and MCS is mediated by other issues. Peters *et al.* (2019) reveal that MCS that is enhanced through the use of a Business Intelligence (BI) system is positively associated with the capabilities to create competitive advantages. Albertini (2019) reveals that MCS can contribute to developing environmental capabilities by focusing on strategic priorities and stimulating dialogue. The statistical results of Wohlgemuth et al. (2019) emphasize that employee participation is a mediator in the use of MCS in identifying and pursuing business opportunities through DC. In other words, the relationship between DC and MCS involves technical, strategic, and individual issues.

In summary, reviewing the literature concerning MCS and organizational capabilities highlights that the role of MCS in organizational capabilities is bound to change over space and time. Other studies that are outside of the categories of the above support this finding. For example, the enactment of MCS is subject to the institutionalization of competing logics (e.g., at the economic and political-economic levels) (Moore 2013), the institutionalization of new MCS techniques (Guerreiro *et al.* 2006), and the implementation of other managerial techniques and institutional contradictions (Sharma *et al.* 2010).

3.2.3 <u>Summary</u>

In conclusion, the MCS-ERP literature and MCS-strategy literature recognize the importance of linking MCS-ERP-strategy issues. The MCS-ERP literature does not merely indicate that accounting changes take place due to ERP, rather it suggests that MCS-ERP-strategy issues could be studied from the perspective of accounting change because accounting changes cannot be understood independently of technologies (Dechow and Mouritsen 2005; Quattrone 2016, 2017; Wagner *et al.* 2011) and strategies (e.g., Baird *et al.* 2019; Kruis *et al.* 2016; Marginson 2002; Simons 1994). Due to the emergence of accounting digitalization in the context of the digitalization-based fast transformation, an MCS research gap emerges: there is a lack of understanding of the digitalization-based MCS role in organizational capabilities in concrete terms.

The literature implies that the relationship between DC and MCS involves technical, strategic, and individual issues. ERP-based MCS is basically concerned with enacting rules, standards, principles, control, and centralization. The enactment covers both social and technical issues. During the enactment, ERP and MCS are mutually affected, and this mutual impact would affect both operational and strategic capabilities that are reflected by concrete strategic actions. Thus, the research gap could be addressed by tracing the connections between social, institutional, and organizational locales that form MCS practices. The next section explicates how Feldman's (2000) theory of organizational routine is employed in this study to trace such connections.

3.3 Conceptual framework

This chapter adopts the theory of organizational routine (TOOR) to reveal the micro-foundation of the accounting change due to the ERP upgrade in the case company (see Diagram 5 Organizational routine and its components and relations). Feldman and Pentland (2003) propose three constructs to understand how organizational routines are generative systems. These constructs are the ostensive aspect (as the abstract ideas), the performative aspect (as concrete observable actions), and the artifacts. The authors explain:

> "…the ostensive and performative aspects of routines are recursively related while the artifacts are distinct from the routine as constituted through this recursive relationship… Artifacts may reflect either the ostensive aspects of a routine (as in the case of a written procedure or a policy statement that describes the overall pattern of the routine) or the performative aspects of a routine (as in the case of a transaction history or tracking database)… Artifacts may also influence either the ostensive aspects of a routine or the performative aspects" (p. 242).

[Insert Diagram 5 here]

These three constructs emphasize a distinction that Feldman (2000) learns from the Actor-network theory (Latour 2005), and help to identify the difference and relations between power in principle and power in practice. They also help to analyze the micro-foundation of accounting changes under study. Common examples of routines concerning the learning process and knowledge include hiring and budgeting routines, and routines for providing services, producing products, and developing new products, which are always developed from simple steps at the early stage into more complicated steps later in the process. I adopted the theory of organizational routine in three ways.

First, I use TOOR to construct the basis for theorizing the components involved in the change process. These concepts help address and view the changes at the micro-foundation level. The ostensive aspect is the ideal or schematic form of a routine, which is the abstract, generalized idea of the routine or the power in principle. MCS could be explained as representing the ostensive aspects of the routine, as it involves actions (e.g., Porter 2001)[45] and power to produce principles, rules, and standards, programs and procedures, hierarchy, and goals (Feldman and Pentland 2003; Galbraith 1973; Parmigiani and Howard-Grenville 2011).[46] This process involves the abstraction, codification, and representations of other organizational actions (Bechky 2003; Burns and Scapens 2000; Carlile 2002; D'Adderio 2003; Dechow and Mouritsen 2005). The performative aspect of the routine consists of specific actions, by specific actors, in specific places and times (Pentland and Rueter 1994), such as everyday business actions. The last construct, artifacts, "may be designed by communities to reflect and support their knowledge and assumptions, therefore also contributing to shaping routines in far more fundamental ways than scholars have acknowledged to date" (D'Adderio 2014, p. 1326). Typical artifacts include written rules, digitally codified procedures, software and computers, and general physical settings (e.g., a factory or an office). ERP lies within the diverse forms of typical artifacts and is a digital artifact to enable negotiation between these two aspects. DC is a higher level of the organizational routine collection consisting of three such components (Biesenthal *et al.* 2019).

These three concepts build a basic understanding of the change in conjunction with the

[45] Porter (2001) defines accounting as a kind of support activities—those not associated with particular logistics activities, operation activities, marketing and sales activities, and activities offering service, but supports all of the activities. For example, MCS involves a set of supportive activities that are not creating revenue directly but being supportive to operational activities.

[46] MCS promotes the operation of "repetitive, recognizable patterns of interdependent organizational activities, carried out by multiple actors" (Feldman and Pentland 2003).

recursive relationship between them. Thus, I can not only identify what change really is at the organizational level (Becker *et al.* 2005) but I can also significantly clarify how to accomplish something to cope with the change.[47]

Second, I apply TOOR to theorize the relationship between MCS and CRM practices in the ERP environment. TOOR suggests a recursive relationship between MCS and CRM involving customer-related actions. This recursion directs attention to the influence of the accounting change on CRM by focusing on the change in the pattern of customer-related actions. Existing research demonstrates that MCS does not only involve actions to describe existing realities, but also it actively produces the realities (e.g., Dionysiou and Tsoukas 2013; Feldman and Pentland 2003; Zbaracki and Bergen 2010), constructs (Quattrone and Hopper 2005), and reconfigures (Robson and Bottausci 2018) them.[48] Notably, according to TOOR, MCS that inscribes part of the knowledge about the action patterns and the associated coordination, communication, and motivation (Carmona *et al.* 2002; Howard-Grenville 2005; Robson 1992; Turner and Rindova 2012) is fundamental to the repeatability of the action patterns and altering the action patterns in favor of new circumstances that emerge (e.g., Batac and Carassus 2009; Bisbe and Otley 2004; Hofstede 1981; Kloot 1997; Shrivastava 1983; Sitkin *et al.* 1994; Tessier and Otley 2012). For example, planning can be used to address challenges following an exogenous shock (Newey and Zahra 2009), thus facilitating operational capabilities leading to better financial performance (Ojha *et al.* 2020).

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[47] For example, a routine may remain stable in its performative aspects but have a different ostensive meaning (i.e., MCS) in this framework. That is to say, the observable changes in MCS would not lead to expected changes in DC simultaneously, because the company represents its routines one way and acts another way, but will over time comes to change both. These types of more nuanced processes can be represented more precisely in the reality where parts of a routine can change while other parts do not at the same time (Becker 2008).

[48] Quattrone and Hopper (2005) state that "…accounting does not reflect reality but constructs it by providing particular forms of organizational visibility and power–knowledge relations". According to Robson and Bottausci (2018), MCS practices were developed to reconfigure or even create organizational space by the setting of cost centers, quantifying activities carried out in these cost centers, and rendering spaces visible and subjects accountable.

Based on TOOR, I can also investigate how CRM practices after the ERP upgrade affect MCS practices. TOOR suggests that customer-related actions can, in turn, change MCS practices after the ERP upgrade. MCS is not fixed in patterns and not closed to change, and may innovate over time (Lillrank 2003). An essential result of engaging in actions is their effect on the structures (i.e., the ostensive aspect) that constrain and enable on-going actions, and "three closely related effects are the creation, maintenance, and modification of organizational routines" (Feldman and Pentland 2003, p. 107). Hence, instead of remaining with a unidirectional view, I could offer a more comprehensive view of the ERP upgrade-induced MCS change.

Third, I adopt TOOR to conceptualize and investigate how the impact of ERP-induced accounting changes on CRM practices influences the development of DC. MA research pertinent to the socio-logic of translation shows that MCS can be seen as a calculative practice (Carmona *et al.* 2002; Dechow and Mouritsen 2005; Parmigiani and Howard-Grenville 2011; Robson and Bottausci 2018; Turner and Rindova 2012). The calculative practices support or undermine alternative configurations of the resource base, making possible the re-evaluation of existing ways of utilizing resources and facilitating existing resources to be repartitioned in order to change the resources base (e.g., Carmona *et al.* 2002). According to TOOR, ERP-induced accounting changes lie within the central role of MCS in both operational and strategic levels. At the operational level, I investigate how ERP-induced accounting changes offer the material context of organizational actions so as to help avoid the actions "grinding to a halt" (e.g., Bechky 2003; Carlile 2004; Pentland *et al.* 2012). At the strategic level, I investigate how ERP-induced accounting changes reflect and encourage the underpinned knowledge and assumptions, making strategy discourse and specific strategy texts visible (Caruth and Humphreys 2008; Sorsa *et al.* 2014).

[Insert Diagram 6]

In summary, Diagram 6 presents an overview of the conceptual framework. I first emphasize that a company needs to face both routine actions and non-routine actions. MCS represents part of the ostensive aspect, significantly affecting individual actors to view their situated actions in the abstract or the ideal form.[49] DC is a superior collection of routine actions, consisting of the even distribution of both the ostensive and the performative aspects of the routine. MCS acts on DC through developing patterned actions inscribed in the ostensive aspect because only the effective use of MCS leads to DC. DC works on the premise of patterned actions. DC also transforms non-routine actions as pattern actions to break through and extend the border of the existing organizational routine. When successfully implemented in a company, ERP can mediate the ostensive and the performative and becomes a mechanism that dictates and embodies the ostensive aspects and shapes the performative (Volkoff *et al.* 2007).

3.4 CRM practices at SunPlants

This section characterizes SunPlants' CRM by providing the background to its products, customers, and markets. SunPlants' CRM is portrayed as being enabled by a digitalization-based MCS. SAP benefits the CRM and MCS in terms of simplified workflow, the constant connection of functional areas, and the deep penetration of the entire business.

SunPlants produces about one thousand and five hundred sets of complete equipment (CE) each year. By 2020, a total of over 2,000 sets of CEs were exported. SunPlants' market share has been one of the top ten in the world over the past five years. Besides, SunPlants has an excellent relationship with some leading petroleum organizations in China, such as Sinopec and PetroChina, because of SunPlants' capabilities in developing a marketing network and providing superb product quality and after-sales services. Such customer relationships enabled SunPlants to maintain its performance in

[49] I have to admit that MCS lies within the boundary between the ostensive aspect and the performative aspect, because MCS also involves conducting situated actions to set principles, rules, and standards, programs, and procedures. The focus of this research is on the performative aspect of these actions per se. Instead, the focus is on the ostensive meaning of their changes and how these changes affect operational actions in the performative aspect.

the downturn period in 2014.

SAP is involved in all the customer-related actions to promote the capabilities: the bidding action, quotation action, contracting actions, sale order, sales forecast, accessories sales actions, delivery actions, after-sales service, sales return/replenishment, sales invoice management, performance and sales analysis. SAP's involvement has the following attributes.

First, SAP simplifies the workflow and keeps every detail of the sales process going. Sales staff can use this unique system throughout the entire marketing process, from quotations, to ordering, to invoices and delivery. What is more, this unique system eliminates data entry errors and dual data entry. Thus, more information and quality analytics help managers make marketing decisions and control sales actions. At the same time, sales personnel may have more time to complete their work and less time to produce business reports.

Second, SAP connects all SunPlants services together, enabling consistent delivery of products and services and ensuring that nothing falls between the cracks. SAP automates most SunPlants' business processes, enabling SunPlants to provide consistent data, information and reporting on a case-by-case basis. In particular, SAP helps produce the knowledge SunPlants needs to meet customer needs, building and maintaining excellent client relationships.

Third, SAP enables the CRM practices to go beyond managing customer contact, but to penetrate the entire business and help to clarify what SunPlants should do to meet customer needs. SAP becomes the central location for all vital data and information across SunPlants. SunPlants significantly reduces the double-entry of information across multiple information systems, ensuring that managers see the latest and most accurate information for decision making and control. As a result, SunPlants can quickly specify concrete actions and configure resources according to customer requirements.

In short, SAP plays an essential role in SunPlants' CRM practice and maintains excellent customer relations. CRM based on SAP is more than a system for managing data and information, but becomes a mechanism for integrating business processes contributing to competitive advantages. We can see the notable advantages from SAP to SunPlants CRM and competitive advantages, but the process in which SAP developed CRM was strenuous. The next section outlines the considerable effort and energy that has been devoted to this process over a period of time.

3.5 Case analysis and findings

This section reports on the accounting change at SunPlants, in its attempt to upgrade ERP to facilitate its MCS, CRM activities, and the development, operation, maintenance, and creation of DC. From Feldman and Pentland's (2003) perspective, the MCS change, as the routine change, should be related to three aspects (i.e., the ostensive, performative, and artifacts) and the changes in their recursive relationship.

Hence, I first deconstruct the routine before and after the ERP upgrade by starting from the "accounts receivable" practices as the fundamental MCS practices and then relatively dynamic MCS practices. Subsequently, I focus on the routine through the artifacts' change and induced changes in the recursive relationship between the ostensive aspect (i.e., MCS) and the performative aspect (i.e., customer-related actions). Finally, I examine how these efforts modify and rebuild the routine into DC.

3.5.1 *Deconstructing the routine*

Through simpler MCS practices (e.g., accounts receivable) and more complex MCS practices to unfold the routine, this section reveals how IT practices that have long been considered as the essential antecedent has continuously shifted the traditional accounting role in managing customer relationships.

3.5.1.1 *Accounts receivable—a simple accounting term while not a simpler artifact*

I exemplify the use of the artifacts through the use of "accounts receivable", as a traditional and familiar accounting practice to professionals. A direct 'accounts receivable' fundamentally represents the customer relationship (Sheth Jagdish 2002).

This is the starting point that I unfold the routine to understand the relationship between MCS and ERP.

"Accounts receivable" is not just an accounting term but a sort of managerial artifact. The ostensive meaning of such an artifact is about the embodiment of accounting principles, rules, standards, and procedures. Then, "accounts receivable" could be used to manage customer-related activities.[50] For effective control outcome, single accounts of "accounts receivable" should be consolidated with other accounts.

> "[The collection of] accounts receivable and payment needs to be linked with the [payment] collection plan"; (PISD 4.14.3)

> "[The system needs] to actualize the consolidated statistical analysis report between multiple sub-companies, such as the accounts receivable of the companies". (PICO 5.1.1)

The quotations describe a more "complicated" need for the use of "accounts receivable". The "accounts receivable" is inherited to set unique formulas and ways of structuring numeric information. The unique formulas are a form of the ostensive aspect, which describes the logic of the pattern of associated activities. Hence, more complex forms of the formula(s) are necessary to describe more sophisticated activity patterns.

However, "accounts receivable" does not work independently; instead, it is connected with other artifacts (e.g., "accounts payable", "cash", and "revenue"). Next, I trace the connection of the artifacts. Such a connection is critical. Based on the research data, the artifact connections result in data or information connections and sharing, and this kind of connection is usually concrete. The artifacts connections need to be understood with the ostensive aspect. Artifact connections are also the result of the connection of principles, rules and standards, programs and procedures, hierarchy, and goals, which are usually abstract—they are the ostensive aspect. The ostensive aspect directs the way to produce data or information, and in turn, data or information keeps the connection of the ostensive aspect. The internal documents indicate that when SAP began to establish this connection, some problems of the old ERP system were encountered:

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[50] For example, when one account receivable is not collected on time, the company is more likely to turn them over to other professionals (e.g., internal investigation or third-party collection agencies) to see if product defects affect the payment, or if it needs negotiating payment plans, settlement offers or pursuing other legal actions.

> "The amount of data and required documents are huge, but the [information] processing efficiency is quite low [in the old systems]; [moreover], there are many financial indicators to be manually calculated; many reports require manual registration, which is time-consuming and inefficient". (PICO 5.1.1)

The connection of various ostensive aspects (i.e., the connection of various principles, rules, and standards, programs and procedures, and hierarchy and goals) is not as straightforward as merely incorporating the number, text, and data. The numerical information recorded for CRM activities includes the value, the quantity of the goods, the payment methods, and the identity of the particular customer. This kind of information is possessed and carried out by other non-accounting artifacts (e.g., contracts, delivery and shipments documents, bank statements) that are denoted to report other actions. In other words, other artifacts embody different activity patterns. "Accounts receivable" report part of the financial effects of transactions with customers, and other artifacts are used to report the performance of the routine from other perspectives.

However, "accounts receivable" is still in a disadvantaged position when connected with other artifacts. As an artifact, its function is fundamentally restricted by the information-processing capacity. The information-processing capability is not the "accounts receivable" property per se, but the artifacts that carry out it.

ERP is the digital artifact carrying out the "accounts receivable", but the information-processing capacity of a particular digital artifact can only hold a limited amount of data and information to process. For example, when using the old ERP, SunPlants worked overtime to complete and finalize "accounts receivable" at the end of each financial year, due to the limited information-processing capability of the old ERP. The old ERP failed to transfer data or information between various managerial artifacts:

> "About 100 accountants were involved in finalizing the financial reports, but that number has been reduced by more than half." (SunPlants Accounting Manager)

Obviously, the connection between accounting artifacts that are produced in accordance with strict accounting rules is rather complex and time-consuming.[51] Thus, it is not an exaggeration to say that connection between accounting artifacts and non-accounting artifacts that are less subject to restricted rules would be more complex.[52] In this situation, according to existing research, more information-processing capacity is consumed to support effective connections if possible (e.g., Baars and Kemper 2008; Davenport and Patil 2012).[53] Hence, the next section will deconstruct the routines so as to study those connections that are more complex and challenging.

3.5.1.2 More dynamics in action patterns

At SunPlants, management control over CRM activities is far more dynamic than the example mentioned above (i.e., via "accounts receivable"). According to my research data, the dynamics need the superior connections of artifacts. One sale order involves various actions across different departments, and the physical distance between them requires communications through through connecting some artifacts and technologies. Individual artifacts cannot accomplish the connection, but the connection of multiple artifacts can. In this respect, the role of ERP is distinguished as follows:

> "The SAP system is rather compelling and ideal… especially in the context where more than 1,000 people are working on it… SAP facilitates the planning function for managing rather complex processes…" (The deputy head of the R&D department)

What existing research has told us is: the connection is not merely a component of a complex system of interactions via corporate narrative documents (Merkl-Davies and Brennan 2017)[54], which involve the exchange of both financial information and non-financial information across the levels of strategy, operation, and management (e.g., Abdel-Maksoud *et al.* 2005; Bhimani and Langfield-Smith 2007; Busco and Quattrone 2015; Chiang and Birtch 2012; Ittner and Larcker 1998). According to the interviewees,

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[51] Fortunately, robotics in finance and accounting gradually relieves this process.

[52] In addition, the data or information of such standardized practices have been verified, and they are less biased and more credible than other internal-reporting information, such as forecasts, unaudited statements, and press releases (Bertomeu*, et al.* 2015).

[53] In most cases, such sort of data is "useless", unless artificial intelligence is adopted. However, in this way, more capacity is consumed.

[54] The notion of the corporate narrative document is similar to the concept of artifacts, which connect the ostensive (e.g., principles, standards, rules, and procedure of conduct) and the performative aspects of the routine and maintain the stability and adaptation of the routine.

the effective routine of dealing with an order for a particular customer should consider multiple pre-defined rules, including cost issues, the time, quality, and geographical issues by related reports and tables.[55] The effectiveness of the connection is about how the information exchange can synthesize these various issues and solve them for particular customers.

In the old ERP, the information of hundreds of customers was embedded in the artifacts (e.g., accounts receivable), however these artifacts were not connected through the old ERP. Subsequently, such "rich" information were not considered to have the better use to promote effective interactions. When the old ERP was present at SunPlants, the actors merely used digital technologies (e.g., Excel) to integrate[56] data or information stored in various artifacts, but the integration is not merely a technical issue:

> "In the past [the old ERP time], we used Excel to integrate the set of accounts and information, and it needs lots of human resources to make the recording and statistics of the information…" (Financial Manager Y)

These reports and tables are a form of managerial artifacts, carrying out the information exchange for the interactions. These tables and reports are related to more than 100 customers. However, at that time of the old ERP, they did not help to promote interactions, even the interactions were not initiated effectively. In other words, the connection is not merely about how much data or information are possessed and exchanged, but how they are used to initiate the interactions:

> "[Before the use of SAP], the [degree] of the actual application of ERP and other information systems was not high, because [the company] did not have a higher standard in the [action] operation. For example, a world-leading company in the industry would strictly do an action in five steps, but the company (SunPlants) only did one or two steps at most times…" (Consultant ZH from the vendor）

Excel did not have the capacity to build effective physical connections (e.g., technology, products, and network connections that allow for effective communications over long

[55] The geographical issues have to take into consideration, because the product sold is large-sized complete sets of equipment and the cost of the installation is high and differs depending upon the geographical features.

[56] There exist differences between integration and connection. For any integration, a connection is a necessity; on the other hand, contrariwise is not always true. Ultimately proper connections based on correct (e.g., ERP) configurations lead to integration, and technologies are used to integrate the artifacts through connecting them continuously, other than merely connecting them temporarily because of the ostensive aspects underpinning the artifacts.

distances). What is more, such kinds of physical connections were unable to promote the effective interaction between the ostensive and performative aspects.

The old ERP neither promoted the connection of both accounting and non-accounting artifacts[57] nor enabled an effective connection between the ostensive and performative: connecting them was complicated. Subsequently, decision-making and control practices relied on intuition:

> "[During the old ERP time], those who are bold dare to do things (e.g., make decisions and take actions) without sufficient data or information…" (Production Manager W)

The old ERP induced *ad hoc* actions that are not patterned behaviors that have been observed by existing organizational research (Dosi *et al.* 2000; Winter 2003), leading to difficulties in management control (i.e. decision-making and control) and inferior routine performance more or less. The use of Excel merely made temporary connections and even led to the separation and isolation of the artifacts. Furthermore, temporary connections merely consolidated the accounts and then produced reports but did not integrate various ostensive aspects.

Besides this, temporary connections would result in the disconnection between the ostensive and performative aspects and cause action patterns to be lost over time. Each department within SunPlants created their private activity patterns, based on the isolated artifacts they currently used, which were usually used independently of the ERP. Furthermore, these activity patterns did not comply with the unified ostensive aspect of the routine at the company level and conflicted more and more with those in other departments.

Deconstructing the routine offers understandings about three types of connection: the connection of the artifacts, the connection of the various ostensive aspects, and the connection of the ostensive and performative aspects). However, a question inevitably arises: how these connections affect decision-making and control? The next section offers an understanding of the connection in more depth and detail.

[57] For example, analysis, effective planning, and control.

3.5.2 Focusing on the routine

By focusing on the routine, this section firstly cues the dysfunction of ERP in transaction-recording that induced the disconnection and loss of the routine. Next, I recognize the ostensive meanings of the mutual impacts of ERP and MCS by understanding how data entry—the cornerstone of performing the organizational routine—was organized at SunPlants. Then, the dominant role of ERP in MCS is reproduced by the recursion between the ostensive and performative aspects. In turn, ERP influences the on-going coupling of the ostensive and performative aspects.

3.5.2.1 ERP as a means of transaction recording-accounting artifacts and operational artefacts

The most fundamental role of ERP in MCS relates to its effect on transaction-recording. The well-acknowledged benefits of ERP in transaction recording and processing (e.g., Jacobs and Bendoly 2003; Scapens and Jazayeri 2003; Singh and Best 2015) were not easily met at SunPlants at that time of the old ERP.[58]

Existing research demonstrates that ERP keeps a record of every transaction (Dowlatshahi 2005), produces managerial reports available for download (Dechow and Mouritsen 2005; Scapens and Jazayeri 2003), provides organized record-keeping structures for transactions (Jacobs and Bendoly 2003), builds a database for transaction entering, recording, processing, monitoring, and reporting (Umble *et al.* 2003), and standardizes business processes that support transaction handling (Holsapple and Sena 2005). My research data shows that the old ERP was not the dominant means of transaction recording and handling because of its technical limitations and poor implementation:

> "I really need to view the monetary amount of production auxiliary consumed and the unit price of the auxiliary materials….so that I could decide on the use of some auxiliary materials in some

[58] For example, the interviews indicate that the designed process is as the following: the sales department can upload the sales budget, and such budgetary information is used by the inventory management team to conduct inventory actions and purchase materials. Upon the purchase of inventory, the system can notify the accounts payable department of the new invoice. An accounting information system can also share information about a new order so that the manufacturing, shipping, and customer service departments are aware of the sale.

circumstances to cope with emerging changes, such as material substitutions due to the shortage of some materials". (Production Manager L)

SunPlants was facing problems using the old ERP in transaction-recording. The mechanism of the "*single database*" was still in use, however the manager was unable to apply or take advantage of it:

"At present [the old ERP time], the sales cost carry-over ledger (accounting system) used by the sales team is not integrated with the existing [old] ERP. There are information islands between the systems... The sales orders [of SunPlants] have not been completely entered into the sales cost carry-over ledger (accounting system). At present, the non-accounting departments have no access to the sales cost carry-over ledger (accounting system) to manage the sales activities, and the sales order needs to be managed outside the system. The sales cost carry-over ledger (accounting system) used by the sales team only manages the sales order information and fails to integrate with the following delivery documents and sales billing." (PISD 4.14.1.1)

These quotations highlight three features of the routine via the use of the old ERP. First, the access to the accounting artifacts was not sharable to other non-accounting actors. Second, not all the sale orders were managed via the accounting artifacts. Third, artifacts designed to accomplish one sale order (e.g., subsequent delivery documents and sales billing) were not connected or integrated. Accordingly, the old ERP was not reliable in performing transaction processing.

Fortunately, SunPlants overcame the technical limitations and poor implementation by upgrading its ERP- the adoption of SAP ERP. Nevertheless, such a difference between extant research findings, the old ERP, and the SAP leads me to further investigate what occurs in the transaction recording in SunPlants. For a better understanding of ERP and MCS, the artifacts are conceptually grouped into *accounting artifacts* and *operational artifacts*. Such dualistic concepts help understand the digital technology applications of the artifacts in two different but independent domains. Table 2 shows the details of these two concepts in the context of the old ERP.

[Insert Table 2 here]

As presented above, the *accounting artifacts* generally have specific financial objectives that are geared towards the *operational artifacts*. These newly-developed concepts are based on the management accounting theory that specifies the use of financial and non-financial information (e.g., Jacobs and Bendoly 2003; Scapens and Jazayeri 2003; Singh and Best 2015), and the study of Dechow and Mouritsen (2005), that distinguishes the effect of ERP on *accounting mode* and *logistic mode* to "craft the locus of management control in different ways" (p. 693). Moreover, *accounting artifacts* and *operational artifacts* work together to unify the organizational routine.

To further understand the issue of the transaction-recording practices, I further investigated the data and information that were recorded in the *accounting* and *operation artifacts*, respectively. In the next section, two main issues concerning the transaction-recording are revealed.

3.5.2.2 Structural (ostensive) looseness of the actions and structural (ostensive) simplicity and standardization

The first issue concerning the transaction-recording relates to how various data and information were organized in the ERP for decision-making and control. The dataset of ERP is technologically based on what is called a "relational database." A relational database is a collection of data and information items. The data and information items involve pre-defined relationships between them and are presented in a table. A table consists of an ordered arrangement of rows and columns. Each row in a table could be marked with a unique identifier of an object (e.g., customer). The rows in the table represent a collection of related values of one object (e.g., time at which a transaction occurs, quantity of goods sold, and account receivable of this transaction). The intersection of a row and a column is called a table cell (or field) that contains a table value (see Diagram 7 for an example of such a table).

[Insert Diagram 7 here]

Table 3 illustrates the characteristics of the table of the old ERP. *The structural (ostensive) simplicity and standardization of the table are due to* the nature of traditional accounting practices whereby the staff are not allowed to add unauthorized data into accounting systems. Meanwhile, the *incompleteness* of the operational artifacts was attributed to the structural (ostensive) looseness of the action of data entry. Thus, for most of the time, the table and the dataset were missing data, with unusable results.

[Insert Table 3 Characteristics of the table in the old ERPhere]

Data entry is fundamental to connecting (operational) actions in the performative aspect with the ostensive aspects.[59] However, the ostensive meaning of MCS legitimates (e.g., to plan, monitor, and evaluate) data entry actions (or tasks) if it is understood as part of the routine and delegitimizes it if it is not. The mechanism is as follows:

> "[Even when SAP is present], data entry [tasks] has not yet been evaluated to a large degree… This is because the common nature of [Chinese] SMEs are characterized as the "*Rule of Man*"… [whereby] the controller requires that data has to be entered before the end of the month when the financial department makes the reconciliation[60]…" (Quality Control staff)

In particular, the quality control staff highlighted the importance of administrative control in conjunction with ERP use to set behavioral constraints. Other interviews show that the administrative controls over (ERP) data entry tasks were not considered necessary in the old ERP. Thus, we can say that merely adopting ERP does not necessarily materialize the ostensive aspect, as revealed by some previous studies (administrative controls of the data entry) (e.g., Lauterbach *et al.* 2020; Wand and Weber 1995), while the administrative controls do not define "how users are provided with system functionality through the functions (algorithms) and data objects implemented in the system" (Lauterbach *et al.* 2020, p. 1025). In other words, the artifacts (i.e., ERP) and the ostensive aspect (i.e., the administrative controls) do not coordinate to enable the actions (i.e., data entry) to be accomplished performatively. Subsequently, the local actors did not compulsorily take the data entry tasks. The deficiency of artifacts and the ostensive aspect moves to unregulated behaviors.

The situation has improved after the ERP upgrade (i.e., SAP adoption). Meanwhile, the

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[59] For example, when a transaction takes place, the sale person has to enter relevant data and information into the system. The transaction could be better recorded for monitoring, tracking and evaluating ostensively.
[60] Reconciliation is an accounting process that uses two sets of records to ensure figures are correct and in agreement.

senior management promoted the change and the use of tighter administrative control over data entry tasks. Such use of tighter administrative control improves the deficiency of the ostensive aspect in terms of structural (ostensive) looseness. Particularly, SAP has imposed the need of local actors to enter data when they are involved in the activities through imposing step-by-step information recording rules. In other words, no one can forgo data entry without authorization. Additionally, the actors in the (similar) horizontal level are permitted to have the opportunity to process a document simultaneously. In other words, well-performed data-entry actions make the effective connection of the ostensive and performative aspects.

The improved connection between the ostensive and performance promoted the use of more sophisticated artifacts to sustain controls over more complicated CRM activities that reflect "experiential wisdom" (Gavetti and Levinthal 2000, p. 113). This is exemplified by the application of the virtual sales order practice:

> "The virtual order [function] is added in SAP, which manages the bidding actions, margin account collection results/opinions, margin type (guarantee letter, performance bond, margin amount), the recording of the actual financial payment date, payment amount, and document number." (PISD 4.14.3.4)

> "The virtual sales order enables several functions, including the order approval function, the performance guarantee, and the deposit process; [61] and after the approval, the accountant responsible for the "accounts receivable" and keeps the records in SAP in accordance with customer bank accounts." (PISD 4.14.3.5)

This enables SunPlants to manage the bidding activities that are essential in the CRM routine. In this way, managers can construct a more visible reality of the company to cope with emerging changes in existing planned goals. In such a reality, SAP shortens the time and space distance between the controlled and the controller, providing more accurate guidelines or operational constraints while leaving more discretional options for concrete actions. Effective actions to the change support developing DC. Hence, SAP facilitates timely decision-making that Barreto (2010, p. 271) considers as "a distinct dimension" of DCs.

[61] The sales department leader, the responsible leader, the finance minister, the financial leader, and the general manager of the company are involved in making the approval.

In summary, at least at SunPlants, tighter administrative controls in conjunction with the use of ERP mutually influence others to prevent mistakes or other harmful behaviors from occurring.

In this section, although the structural (ostensive) looseness of the actions and structural (ostensive) simplicity and standardization reveal how the ostensive and performative aspects of organizational routines are basically connected through well-performed data entry and transaction-recording, they are not sufficient to explain why data entry and transaction-recording was difficult to perform well through the use of old ERP in details. Then, the next section focusing on explaining the unpleasant experience of data entry and transaction-recording when SunPlants was using the old ERP.

3.5.2.3 <u>Inconsistent methods and fragmented routine</u>

The second issue concerning the transaction-recording relates to how different artifacts are consistent (e.g., uniformity of the content) for decision-making and control. According to the interviews, the lack of common artifacts leads to the use of inconsistent artifacts,[62] which have made the data and information to be produced and processed in various ways. Common artifacts work under a unified ostensive aspect, which are manifest as the common word- or data-editing applications. Common artifacts enable data updates and actions to follow a logically defined sequence (i.e., the ostensive aspect) based on the business needs. In addition, the lack of common artifacts has caused actors to be unaware of others' actions because they only see the artifacts of their own actions in dealing with the orders. They may believe that they were doing the "right thing" based on their preferred artifacts, the rules embodied, and the information available. Instead, they did not follow an efficient and uniform flow of works under defined controls (i.e., the ostensive aspect).

Before SAP, the lack of *common artifacts* manifests in two ways. First, each department used their preferred artifacts to record the customer information, including paper

[62] Especially, there was lack of common search and reporting utilities (i.e., artifacts) to generate reports based on various parameters.

recording, self-made software, and ERP. Several departments had access to customer information, such as the sales department, plants, service department, and project department. Second, even in the central marketing department, customer information was recorded differently. Some customer (or transaction) data and information were recorded in paper documents, whereas some were recorded using self-developed software outside ERP. As a result, one customer had multiple identity codes as different data or information objects at SunPlants. Table 4 shows the quotations from the documents that highlight the effect of the lack of *common artifacts*.

[Insert Table 4 here]

Various inconsistent artifacts produce duplicated data and information objects to reflect the same physical objects within the company. Furthermore, different artifacts and information objects are also ostensively underpinned by different principles and rules, and thus, in fact, multiple conflicting control mechanisms were enacted at SunPlants.

As a result, CRM activities were negatively affected. Customer (or transaction) data and information were not well-managed, as the information of one customer with multiple identities at SunPlants could not be easily organized into a unique set of accounts. Gradually, when the data aggregation process continued over time, the customer (or transaction) data and information became increasingly fragmented. Such low-quality data and information generated confusing reports, distorting the improvement of the activity pattern and the ostensive aspect. Tension arose in the ostensive aspect, and then disorder occurred in the performative aspect of the CRM routine. For example, the contract approval process that is core to CRM was troublesome when the old ERP was present:

> "There are many departments involved in the sales contract approval process, and the cycle is rather long. It usually takes two days for a contract to complete the approval. The maximum approval time can be up to one week. At present, each sales contract requires approval, and the contract review process is not uniform, and there is no unified interface… Moreover, the approval linkage and departments involved in each set of approval processes are also different." (PISD 4.14.1.1)

> "The departments involved in the review and approval process are based on a horizontal relationship, without prioritization, and each does not affect the approval of other departments." (PISD 4.14.1.5)

These two quotations describe a messy contract approval process where inconsistent artifacts were not conducive to building a unified ostensive aspect to refer, specify, and prioritize the activities among the departments simultaneously. Each department failed to conduct specific actions via *common artifacts* or to orderly enact every review and approval action.

The interviews reveal that *common artifacts* should be designed across the boundaries, as the "single database technology" of ERP is not only about connecting data and information per se, but about how data and information promote the connectivity of actions in the real world: how data and information that demonstrate the objective, immutable values and measured outcomes of things or actions that have been done can promote the connectivity of different organizational activities to generate value. SAP supported the management team in developing some *common artifacts* throughout the routine, especially the workflow and reporting utilities. The effect is notable:

> "When the goods dispatched are posted in SAP, the inventory deduction overlaps the accounting document generation…" (PISD 4.14.3.1)

> "After having been approved by the R&D center, the spare parts dispatched with the host machine are updated from the PLM module to the sales order..." (PISD 4.14.3.2)

> "The contents of the sales package are reflected in the outbound order…" (PISD 4.14.3.3)

In this way, each behavior and activity is performed by following an efficient and uniform workflow under unified ostensive aspects. Also, data updates and actions follow a logically defined sequence; common words are used in the communication channel across different functional departments within SunPlants.

For example, SunPlants could detail the transaction information and specify information-processing actions. In addition to the superior information-processing capability, SAP specifies the transaction details (i.e., the documenting date, posting date, invoicing date, and translating date). The dataset and the ostensive aspect were extended because this feature established the ostensive foundation for the data entry actions, and the system ostensively captured and identified more operational actions for extending the ostensive aspect. Also, SAP helped SunPlants to specify information-processing actions (i.e., document-holding, documents-parking, and document-posting). This feature specifies the situation that actors encounter during the data or information recording process. Actors could ensure that all the transactional data and information produced during operational actions are able to be recorded, transferred, and communicated. These two features impose controls over operational actions by completing the circular loop of cybernetics while facilitating flexibility in data entry actions and capturing routine dynamics.

By focusing on the routine, I identify the importance of, first, securing the dominant role of ERP in MCS, second, the ostensive meaning and performative significance of the data-entry tasks by looking inside the artifacts, and third, the consistent use of artifacts to build unified activity patterns from looking outside of the artifacts.

However, a question naturally arises: how can improved control mechanisms and decision-making processes that are based on consistent artifacts and coherent routines components contribute to organizational performance? The next section discusses how the routine is rebuilt by SAP to better organizational performance.

3.5.3 *Rebuilding the routine as capabilities delivering better organizational performance*

It is well documented in the literature that neither can the MCS practices be studied in isolation (Dechow and Mouritsen 2005), nor can their changes be studied alone (Malmi and Brown 2008). In this respect, rather than discussing the impact of each MCS change on DC, instead, I focus on their joint outcomes.

Furthermore, following on from understanding the technical ERP features required to rebuild the routine via MCS, I have isolated the increasingly transparent "bottom of the operation" as the core joint outcome of the post-upgrading of ERP and MCS change. The transparent bottom of the operation directly benefits the seizing routine and reconfiguring routine. However, ERP-based MCS and CRM practices did not perform well in sensing routine and non-routine activities.

3.5.3.1 Seizing and reconfiguring routines

The research data highlights the impact of the post-upgrading of ERP on both seizing and reconfiguring routines. Contracting practice provides an example. Contracts are undertaken to meet the customer's requirements. Existing research implies the relevance of MCS to implement the contract with customers (e.g., Berry *et al.* 1995; Davila *et al.* 2009; Dekker 2004). For example, nearly all contractual terms are accountable in the form of recording costs, value, and profit. A contract is also the trigger for producing various documents. At SunPlants, the contract is essential in how an upstream document is extracted and then transfers data or information to the downstream artifacts. This SAP ERP facilitates the contracting practices to develop the seizing routine that explicates the actions necessary to remain competitive with customers and to reconfigure the routine that specifies concrete actions to meet customers' needs.

At SunPlants, numerous managerial artifacts were maintained to illustrate how to rapidly seize a business opportunity from the contract. Due to the manufacturing to order (MTO) nature of SunPlants, the contract details reflect the negotiation to achieve an order. The contract is essential because it can be extracted to communicate with its downstream artifacts associated with specific actions, including design, production, delivery, transportation, payment, and after-sales service. In addition, contracts are always legally binding. Missed deadlines and obligations could result in huge losses, as SunPlants' primary customers are oil giant organizations. Numerous managerial artifacts were involved in translating the sale order to inform the sequencing actions, in order to keep SunPlants fulfilling every obligation within the set terms by taking action quickly and correctly.

SunPlants' CEO has emphasized that contracts that were not well-refined could cost it further business opportunities or change relationships with core customers, and ultimately lead to a loss of business and slowed growth. Before the ERP upgrade, numerous managerial artifacts connected with the old ERP resulted in a slow contract cycle that delayed SunPlants from recognizing revenue, inducing contract litigation. Hence, my attention was directed to the contract content kept in the old ERP:

> "The main contents of the contract relate to the subject matter (goods to deliver), quantity, sales price, delivery date, payment method, and warranty period…"

The contract seemed to contain the necessary components, but the contents were not sufficient. Not surprisingly, the contract was believed to be problematic in content details:

> "[When the old ERP was present], the contract does not include the unit price, additional charge, packing expenses, delivery expenses, and unloading charge, and the pricing details about a single order are usually not available. This is because the system is unable to offer such details to include in the contract." (PISD 3.5.1.4)

Subsequently, using the old ERP, the sales team usually accepted orders without knowing the profitability of that order; the estimates of the amounts were hard to evaluate and summarize into total costs in order to make decisions:

> "…the equipment (the final product) significantly consists of iron. Sometimes we can easily know [whether] an order has no profit because the price is lower than the value in accordance with the unit price of iron and the total weight of iron…." (Production Manager W)

> "[In the old ERP], the execution of the sales order needs to be judged through external communication and human control…" (PISD 4.14.1)

Human intervention in the contracting practices led to the failure to capture the dynamics of the action patterns and then to make proper plans to support rapid action-taking. To solve this problem, SunPlants made an effort to make the contract more detailed:

> "In the past (the old ERP time), accounting staff had tried their best to calculate the total price of the final product, and it was difficult to detail the consumption of the material, the labor and the overheads [associated with one order]." (SP CFO)

> "SAP imposes tighter rules on the operation line. It is much more elaborate… That means it starts from the very bottom of the operation…" (Accounting Manager)

The bottom of the operation refers to the fundamental constituents of and the mechanism of the routine. Each objective of the bottom of the operation is concretely operated in the performative aspect and is reflected in the ostensive aspect in an abstract form. When the old ERP was used, the contract content details were impossible to re-define or extend because the bottom of the operation was unclear. When SAP made the bottom of the operation transparent, the MCS had clearer objectives (i.e., particular actions and resources). The way to specify the actions was well-specified and inscribed in MCS. Then, the effective use of MCS kept the seizing routine to develop over time continuously.

The transparent bottom of the operation benefits the reconfiguring routine by supporting taking quick correction. The bottom of the operation significantly relates to how actors perform the actions. If a contract is not executed accurately, SunPlants will face massive costs in the form of overpayments or late payments by the customer(s). This leads to severe cash liquidity risk and reputational damage. A transparent bottom of the operation system enables numerous managerial artifacts to recognize the variations of each action, supporting the further specification of the actions when changes occur.

Also, the artifacts support the generation of new knowledge and MCS accumulation for developing action patterns. Through the bottom of the operation, new knowledge is accumulated in order to enable the effective use of MCS to maintain or alter action patterns to create competitive advantages. For example, the CFO of SunPlants and her colleagues tried their best to extract and detail the contract content so as to analyze the increasingly lower profitability of the products. They realized that the contract should be re-defined and extended from the bottom of the operation in order to produce a broader scope of data and information for effective decision-making and control. Additionally, SAP encourages managers to use the artifacts and information to further support maintaining, and even altering, the action patterns through more analysis of the operational actions. Although SAP is more concerned with the technical aspect of the change, the effect is noticeable:

> “Before the adoption of SAP, sales teams relied upon their own “experience” to evaluate the profitability of an order, irrespective of comparing the profitability among identical orders… Most of the less profitable orders were accepted, and thus more profitable orders were influenced, and most orders were delayed…” (Production Manager W)

Reconfiguring routine is developed through SAP, and the fundamental attributes[63] are teased out further and are taken into consideration before performing the actions. With an effective reconfiguring routine, SunPlants can take rapid action.

Additionally, new knowledge is produced and retained in the contracting practice, facilitating opportunities to improve the contract and speed up the contract cycle. The contracting practice becomes supportive of the reconfiguring routine. It helps MCS to make better plans to specify actions in order to fit various circumstances, with clear milestones that need to be met accurately.

However, most of the interviewees have mentioned that the accumulation of MCS to develop the seizing and reconfiguring routines could not be completely reached in a relatively rapid way by means of ERP. Indeed, this process would take five or more years. This fact emphasizes the nature of organizational routines, which are slow to change; moreover, the development of DCs is also an evolutionary process that is linked with selected attributes from the bottom of the operating action and routine (Zollo and Winter 2002).

This ERP upgrade directly influences the seizing and reconfiguring routine, but not the sensing routine. The next section illustrates how SunPlants has made an effort to develop the sensing routine.

3.5.3.2 *ERP, non-routine tasks, and dynamic capabilities*

The ERP upgrade was not able to deal with non-routine actions effectively. This section exemplifies this weakness through the system's failure to deal with the warranty claim and identifies external challenges in new product development.

Carrying out the warranty is a means of enhancing trust among customers to maintain a good relationship with the customer or even to build a relationship with new customers. When a customer claims a warranty, a warranty order is created to repair or

[63] For example, the unit price, additional charge, packing expenses, delivery expenses, and unloading charge, and the pricing details.

replace the product(s) sold, and this order then induces costs. This sort of cost has a role in the control over the maintenance of customer relationships.

At SunPlants, SAP could not support the ongoing tracing of the product returns, after which the controls over the product return processes are problematic. SunPlants had to deal with the product returns case-by-case, without any particular system in place. Some products would be dissembled into different parts for various purposes, some would be refurbished and consume additional resources, while some were scrapped and induced expenses. In other words, although all of the actions were routine tasks, they did not perform as a routine.

Generally speaking, there was no one recurrent action pattern specified to deal with the product return effectively. There was no ostensive aspect for the return-related actions, and no artifact was explicitly designated for the actions. For example, performance measurements did not clearly illustrate how to evaluate the actions dealing with the product return, and then the actions shared accounts with other common actions. That is to say, this was non-routine, at least at SunPlants. Two IT experts believed that SAP could not currently solve this problem, and that no ERP could solve it either. I do not intend to verify whether what the experts said was correct or incorrect, however their comments suggest a need to further look into this process to recognize the pattern(s) and develop a routine.

The research data shows that SAP supports creating competitive advantages based on existing resources and established routines by providing them efficiency (e.g., through the seizing routine and reconfiguring routine). However, it appears impossible for SAP to develop the sensing routine to cope with challenges imposed by performing non-routine actions (I will discuss later how SAP could work with other digital technologies to provide joint sensing capabilities). At SunPlants, the ERP upgrade that is built upon the premise of routinization has enabled the MCS to quickly define the way to specify actions in order to deliver an order and meet customer needs.

Nevertheless, due to the premise of routinization, the ERP upgrade has failed to develop the sensing routine. The ERP upgrade did not enable SunPlants to precisely define how a non-routine action should be connected with a particular action pattern or the possibility of the action pattern becoming repeatable and competitive. The interviews imply that opportunities are associated with identifying and retaining non-routine actions by developing the sensing routine. More specifically, DCs are concerned about dealing with problems that are out of the current action course and how to be aware of the possibility of non-routine actions in order to be competitive.

Another issue relates to the use of ERP in sensing external challenges. One main external challenge is from rivals introducing new products. Technology embodies a means by which to solve a problem (Arthur 2009). SunPlants attempted to respond to this challenge by recognizing the upgrade need of the product sold by obtaining engineering data from the sold product. Table 5 shows the benefits of such engineering data. This type of technology enables an artifact that offers a direct linkage between SunPlants and markets so as to rapidly sense customer needs in the form of equipment upgrades and parts updates.

[Insert Table 5 here]

Therefore, SunPlants could actively promote marketing and contracting practices in the seizing routine, and design and production practices in the reconfiguring routine. This technology corresponds with the current understanding of organizational routines as both emergent and generative (Parmigiani and Howard-Grenville 2011). IT practices can offer mechanisms through which solutions can be intentionally promoted, which then become the basis for actions that can be reproduced, and subsequently revised or recombined, to create new patterns. Some interviewees indicated that the engineering data generated during the daily operation of the machine (a final product that SunPlants has sold to the customer) could be useful:

> "This sort of information can enable the company to boost its sales revenue… The profit of complete sets of equipment is not too high due to competition, but the spare [of the equipment] that is used for after-sales service is relatively profitable, as most of the spares are customized and non-standardized…. The current revenue of this type of business is only 30 million Yuan per year, however the actual market is about 120 million Yuan… Nonetheless, SunPlants cannot transfer this

opportunity, but they are attempting to achieve it by advancing its information system… Advancing the information system not only helps to capture the opportunity but also helps them allocate resources to execute the production…" (Senior Manager Y of the vendor)

This case could emphasize that ERP is not omnipotent, such as developing the sensing routine in this way. The ERP upgrade has failed to extend the routine and produce competitive advantages beyond the existing course of action patterns and resources. However, admittedly, the ERP upgrade enables the effective use of numerical artifacts. Next, SunPlants started to clearly recognize the innovative ways to use artifacts in order to cope with increasing external challenges. The management team emphasized that artifacts should be designed towards the final targets, other than the actors, tasks, and systems that mediate the final target. On the other hand, too much attention given to improving existing routines drains organizational resources and brings about "core rigidities." The implication I noted from the development of the sensing routine is that organizational routines should target the products, markets, and customers, from which the company receives information about what is unclear but important with regard to the company. In summary, SAP effectively manages the resources to meet the target but is not sufficient to meet and deliver the target and identify areas that do not fit the target. This consumes other digital artifacts in conjunction with the use of MCS to define, specify, monitor, and evaluate the targets. Otherwise, the organizational routine is more likely to remain the same.

3.6 Discussion

3.6.1 *Management control and ERP in organizational routines*

The research evidence reveals three fundamental MCS changes that occurred due to the ERP upgrade. The first is the enhanced constant technical and physical connections between non-financial and financial information that are produced by and for customer-related actions. The second is the unified and consistent manner to abstract the action pattern by using MCS. The third is the enhanced capability of MCS to penetrate the bottom of the operation, through re-defining the fundamental constituents of MCS information. Subsequently, these changes enable MCS to capture the action patterns in which the company performs for a particular customer and then manages the complexities and dynamics associated with the needs of all customers.

Based on Feldman and Pentland (2003), these changes further imply that the relationship between MCS and ERP could be understood in two ways. First, these changes emphasize the recursive relationship between organizational routines and digital artifacts by showing how improper ERP use in the routine creates challenges in establishing effective action patterns. Furthermore, how ERP could secure a dominant role in the routine is critical in making effective MCS changes in the long term. In this respect, existing research also indicates that most actors prefer to retain use of the legacy (old) systems when ERP is being adopted (Granlund and Malmi 2002; Scapens and Jazayeri 2003). This research emphasizes that the ERP's role would be undermined and taken over by the inferior technologies and systems or other means (e.g., manual approach) because the inferior requires less effort to learn. To prevent a unified organizational routine from being broken up and replaced by unrepeatable action patterns, the connection and integration of accounting artifacts and the operational artifacts requires ongoing learning efforts that would last several years. Evidence concerning the improper use of ERP in the routine, and failure to maintain the dominant role of ERP in the routine, extends the understanding of what ERP makes impossible that is interested by accounting scholars, such as Dechow and Mouritsen (2005).

[Insert Table 6 here]

Second, SAP rebuilds the recursive relationship *within* the routine and *between* the routine and artifacts because this upgrade enables a “single database” advantage in order to maintain constant connections between them. Table 6 summarizes a more profound understanding of the connection. It is worth noting that most companies can obtain a “single database” by purchasing ERP systems, but not everyone can benefit from the advantages.[64] Consistent with existing research (e.g., Dechow and Mouritsen 2005; Wagner *et al.* 2011), SAP that offers the connections helps SunPlants to benefit from the post-upgrading of ERP that enhances database technology.

3.6.2 ERP-enabled MSC and dynamic capabilities

These changes affect the development of DC in three ways. First, the three MCS changes (information connection at the artifact aspect, action pattern abstraction at the ostensive aspect, and bottom penetration at the performative aspect) help to rebuild the routine as follows. First, managers effectively cope with the increasing complexities and dynamics in CRM practice, facilitating the seizing of market opportunities from customers. Second, the MCS then supports forming goals that direct reconfiguring and matching the resources in order to develop new products and extend particular markets. Third, MCS built upon the ERP for managing internal actions is not effective in sensing market opportunities and threats. To be more effective in sensing these opportunities, ERP should incorporate other digital artifacts so as to develop connectivity to the external parties to support the accumulation of MCS. These findings highlight the importance of the continuous development of the artifacts in developing effective action patterns.

Indeed, SAP (i.e., the ERP upgrade) implants technological and managerial innovation into routines and capabilities. Technological innovation refers to the broader physical memory space for transaction recording and faster speed that strengthens the connectivity of the artifacts. Managerial innovation refers to developing new possible action patterns through common artifacts. However, the impact of the upgrade differs (e.g., Wagner *et al.* 2011) depending upon different routines of the DC (i.e., sensing, seizing, and reconfiguring routines).

At SunPlants, the ERP upgrade facilitates the development of common artifacts. The common artifacts then work together to lead to some benefits that are considered

[64] For example, SunPlants used an old ERP system for 10 years (before the year of 2013) but did not attain many benefits.

important by previous studies, such as unifying the ostensive aspect, standardizing the action patterns, normalizing the variations that occur during routine repetition, and supporting the routine repeatability (e.g., Biesenthal *et al.* 2019; Scapens and Jazayeri 2003; Sele and Grand 2016). These benefits effectively facilitate the seizing and reconfiguring routines through embodying, visualizing action patterns to rapidly manage the customers' needs, and optimizing the use of resources to reach the (sales) order.

However, the use of SAP has a limited role in developing DCs at SunPlants. DC requires the effective use of the sensing routine to identify environmental changes and opportunities (e.g., Di Stefano *et al.* 2014; Yeow *et al.* 2018), the constant surveillance of markets and technologies (Teece *et al.* 1997), and a willingness to adopt the best practices and to benchmark progress (Braganza *et al.* 2017, p. 330). An effective routine requires endogenous development and constant improvement (Teece 2009) through the connectivity to the external parties to sense changes and opportunities. Although SAP enables common artifacts, SAP does not directly support managers in developing this kind of connectivity.

SAP per se is not sufficient to build all three DC routines and reach mutual effects, but rather the seizing and reconfiguring routines build a foundation for the sensing routine. Consistent with some existing studies demonstrating the importance of software supplements external to the ERP (e.g., Dechow and Mouritsen 2005; van Roekel and van der Steen 2019; Wagner *et al.* 2011), this chapter shows that SAP does not directly provide the artifact (e.g., extra (Input/Output) development, external sensor, RFID, or even a bar code) to properly connect with the product development, but SAP provides the actors with a vision of how the connections and integrations should occur (see Diagram 8). In summary, SAP is not adequate for the development of new product types or expanding market size, however, this gives rise to an opportunity to explore how SAP can integrate with other digital artifacts to facilitate NPD practices.

[Insert Diagram 8 here]

3.7 Conclusion

This chapter reveals three MCS changes (i.e., enhanced information connection at the artifact aspect, action pattern abstraction at the ostensive aspect, and bottom penetration at the performative aspect) due to an ERP upgrade and how their impacts directly help to develop the seizing and reconfiguring routines, but not the sensing routine. The changes and impacts lie within the constant connections between the artifacts that handle organizational actions and, thus, effectively integrate principles, rules, standards, programs, and procedures that underpin organizational actions of various kinds. The findings suggest that the post-upgrading of ERP is more than the role of the initial ERP adoption in forming a tight connection between business functions into a single system (Newell *et al.* 2003) at the level of information or physical systems (Dechow and Mouritsen 2005; Quattrone and Hopper 2005). Instead, the post-upgrading of ERP focuses on integrating the MCS at the artifact levels, the ostensive and the performative levels.

This chapter provides the following contributions. First, it contributes to the MCS-ERP literature by revealing and tracing how the three major ERP upgrade-based MCS changes have been created (i.e., through enhanced information connection at the artifact aspect, action pattern abstraction at the ostensive aspect, and bottom penetration at the performative aspect). The impact of the post-upgrading of ERP on accounting practices has been recognized (Wagner *et al.* 2011), however the existing MCS-ERP literature might have no opportunity to observe the post-upgrading of ERP. This chapter bridges this research gap by focusing on the post-upgrading of ERP.

This chapter also highlights that the ERP upgrade-based MCS changes may occur simultaneously at various levels (i.e., the ostensive aspect, performative aspect, and the artifacts aspect), instead of appearing at the level of information or physical systems (Dechow and Mouritsen 2005; Quattrone and Hopper 2005) in the initial ERP adoption. Knowledge about the three changes could suggest future MCS-ERP studies, especially those concerning the post-upgrading of ERP, focusing on how MCS changes occur simultaneously at various abstract and concrete levels.

Second, the three constructs developed in this chapter (i.e., accounting and operational artifacts, and common artifacts) might theoretically contribute to the organizational routine theory. These three concepts respond to recent calls to build connections between capabilities and organizational routine (e.g., Howard-Grenville and Rerup 2016; Parmigiani and Howard-Grenville 2011).

Accounting and operational artifacts represent specific artifacts that are produced in different operational (performative) areas. In this chapter, they are characterized as having different functions, posting/update times, and connections (i.e., widely connected, or isolated). Common artifacts show how specific artifacts are further connected, transformed, and maintained for effective decision-making and control practices in three core strategic routines (e.g., sensing, seizing, and reconfiguring routines). These three constructs suggest possible future organizational routine theory-based studies: accounting and operational artifacts could work together to promote and navigate the challenging process of creating and replicating new routines across multiple functional areas within a company.

Third, this chapter contributes to understanding the practical ways of developing DC by exploring how the impact of the post-upgrading of ERP on CRM and MCS differs in three different DC routines. Researchers have recognized the importance of studying the practical ways of developing DC to compete in increasingly dynamic environments (e.g., Ambrosini and Bowman 2009; Dixon *et al.* 2014; Salvato and Vassolo 2018; Zahra *et al.* 2006). I demonstrate how the specific benefits (e.g., the broader physical memory space for transaction recording) involved in the post-upgrading of ERP improve the concrete accounting practices (e.g., accounts receivable) of CRM in order to facilitate specific customer-related actions leading to different DC routines. This informs the senior managers, who may not have had satisfactory ERP experiences, to notice that ERP per se might not promote accounting practices. Accounting practices could therefore be promoted by ERP when specific ERP functions and modules are properly selected and implemented.

Furthermore, I reveal the critical role of the flexible use of other digital artifacts producing engineering data to facilitate ERP and MCS to the three DC routines. This knowledge suggests to those managers who wish to make the business-accounting integration (yè cái róng hé, 业财融合[65]) that this integration is not merely about merging data. It is also concerned with the use of physical-digital technologies to make extensive data collection, extraction and connection, and business process reduction.

Although I have identified some contributions in this chapter, this chapter is bound to some limitations. This chapter is based on the general concepts of the organizational routine, without specification of the routine components. For example, the ostensive aspect seems to differ from the abstract level to the less abstract level (e.g., formal accounting controls vs. cultural controls). This chapter does not investigate the various dimensions of the artifacts because the focus is to produce a general picture of the relationship between routine and artifacts from an accounting perspective. On the other hand, artifacts have instrumental, aesthetic, and symbolic dimensions (Rafaeli and Vilnai-Yavetz 2004; Vilnai-Yavetz and Rafaeli 2006). Artifacts are at the center of organizational routine and play a key role in debates about materialism and agency (Pentland and Feldman 2008). Hence, future research is encouraged to explore the more specific aspects of routines and artifacts, which might help to show how MCS collaborates with new digital technologies or artifacts to improve routines and boost organizational performance.

Additionally, this chapter focuses on applying digital technologies in management control over customer-related actions and CRM practices. These actions and practices are not as complicated as those specified in production and R&D processes; for example, in action planning (e.g., daily-based plans), real-time performance/variance feedback or cybernetic controls (e.g., based on each day or even an order), compensation plans (e.g., based on individuals), and organizational structure (e.g., the integration of departments). Further studies are suggested to look into production or R&D contexts that may generate excellent outcomes concerning how a company can develop DC by

[65] This term is popular in China's accounting research arena, which could be basically understood as the integration of the management accounting tools and methods based on business processes.

digital technologies and MCS practices.

Diagram 5 Organizational routine and its components and relations

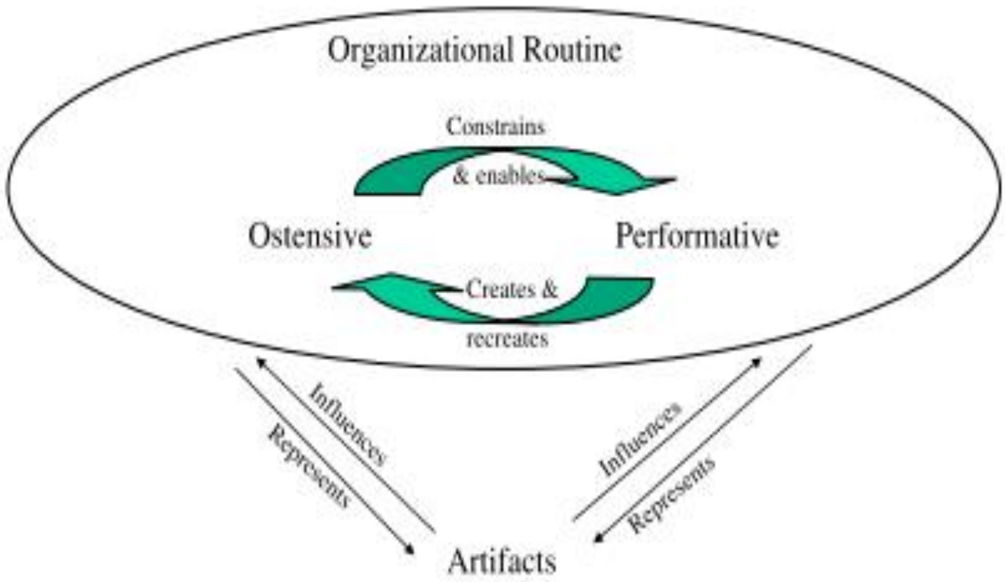


Diagram 6 Overview of the conceptual framework

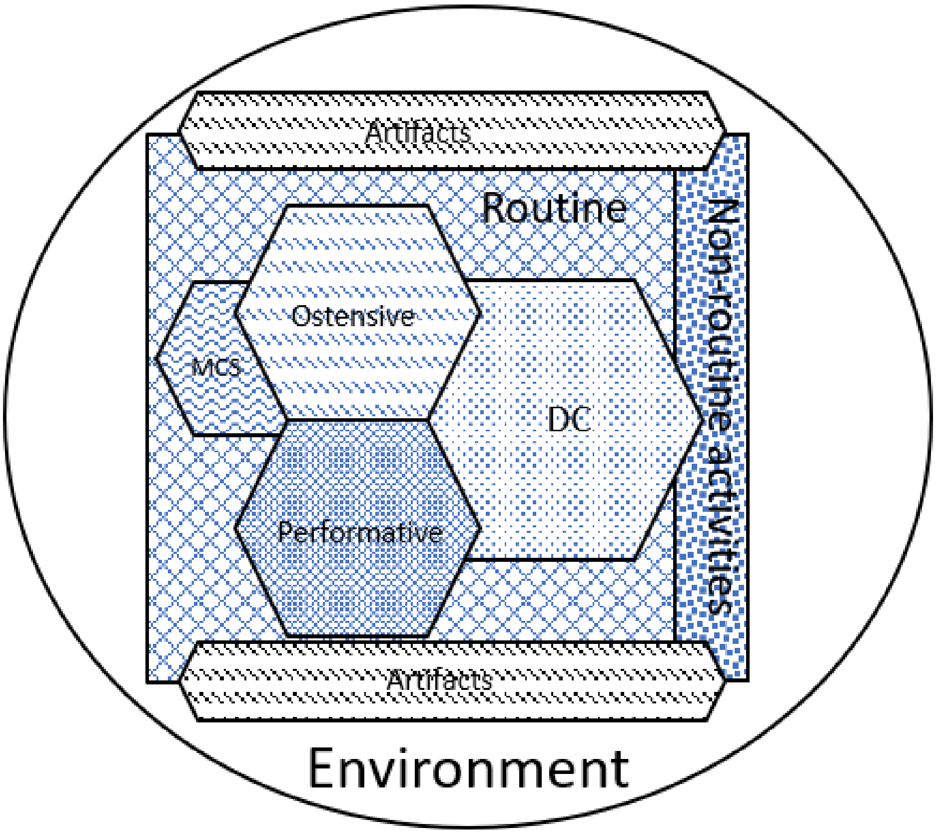
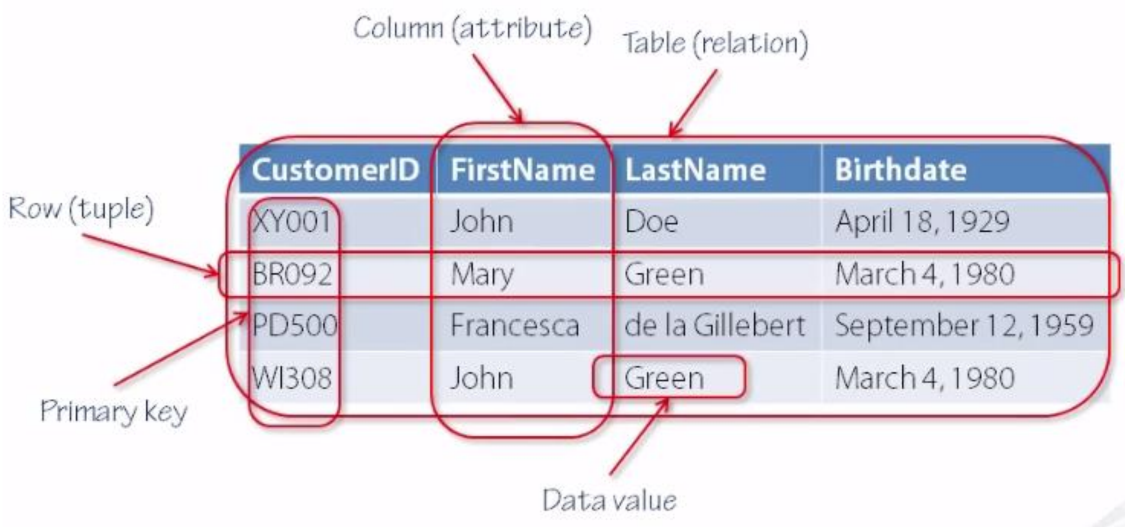


Table 2 Accounting artifacts and operational artifacts

	Accounting artifacts	Operational artifacts
Function	• Accounting artifacts should provide accurate, verifiable, and objective data to regularly update the financial status of the performative aspect of the routine • Accounting artifacts should be involved in decision-making in the financial area	• Operational artifacts should monitor and evaluate the non-monetary performance and efficiency of the performative aspect, to make improvements and address problems, such as lead-time and quality • Operational artifacts should be associated with assigning tasks, allocating resources, setting employee priorities, and anything that occurs immediately, daily, or at most weekly
Posting/update time	• Accounting artifacts are posted or updated independently of the operational artifacts, due to the time difference between the transaction occurred and the accounting documents generated and received and then posted to formal accounts	• Operational artifacts should be usually updated earlier than the accounting artifacts, such as the order information, delivery information
Collected by	• Sales team	• Non-Sale team
Connection	• Accounting artifacts were partly connected with each accounting artifact (in the old ERP) • Accounting artifacts were not digitally connected with operational artifacts (in the old ERP)	• Operational artifacts were partly connected with each operational artifact (in the old ERP) • Operational artifacts were not digitally connected with accounting artifacts (in the old ERP)
IS dysfunction	• The old ERP was unable to support the accounting artifacts to record more data and information, as it did not have more sufficient fields to enter the details (i.e., it merely consisted of two or three journal entries to record one transaction, without any details of the accounting documents) • The old ERP was unable to enable continuous connections of the accounting artifacts and the operational artifacts • The old ERP did not provide access to the accounting system, thus inducing the use of alternative means to maintain the efficiency of the sale actions (e.g., ordering, pricing and credit assessment)	

Diagram 7 Sample of a table



CustomerID	FirstName	LastName	Birthdate
XY001	John	Doe	April 18, 1929
BR092	Mary	Green	March 4, 1980
PD500	Francesca	de la Gillebert	September 12, 1959
WI308	John	Green	March 4, 1980

Sourced from: https://medium.com/@oliverknocklein/visualizing-sql-a-beginners-guide-to-relational-databases-c2dcfda79ea4

Table 3 Characteristics of the table in the old ERP

	Structure	Completion
Nature	• The structure is more associated with the design of the managerial artifacts • The structure is basically embodied as how many columns are configured with rows and other tables	• Completion is relevant to how the data-entry is completed
Linkage with the organizational routine	• The structure is about the ostensive understandings of the actions performed daily • The structure is concerned with the guiding role of accounting in the performative aspect	• Completion is more closely linked to the rules on the application of artifacts in daily work. • The completion is concerned more about how to ensure the enactment of the ostensive aspect
Linkage with the accounting and operational artifacts	• The accounting artifacts (in the old ERP) consists of relatively short columns and data • The short columns and data embedded in the accounting artifacts (in the old ERP) were attributed to the structural (ostensive) simplicity and standardization of the nature of traditional accounting practices	• The operational artifacts were extremely incomplete (in the old ERP), to a large degree • The incompleteness of the operational artifacts (in the old ERP) was attributed to the structural (ostensive) looseness of data entry
	• Effective decision-making and control practices require more information and a better	

Table 4 Quotations that highlight the effect of the lack of common artifacts at that time of the old ERP

Descriptions	Effect on
"Information transmission was weak…… The execution of the sales order had to be judged by external communication and human checks..."	Sale order processing
"Sales returns (host, accessories, warranty parts) were not handled as part of the sales return order [information]. At present, the sales return action is always basically a free return, triggered by the inspection and a delivery receipt submitted by the service department… And the return management was not used, and the tracking history query of the return was difficult."	Sale return transactions
"After-sales service was not managed digitally, and then manual methods were adopted to manage service actions, and thus, making a historical record query was not easy."	After-sales service
"Customer master data management was scattered and not managed uniformly. The sales department, accessory company, after-sales service department, and engineering project department could manage customers, and thus they repeated the same customer data…. Paper documents managed some customer data… some customer data were managed by self-made software... Management control practices were not consistent, and customer data managed by in-house software was duplicated and not coded consistently by customers..."	Customer information

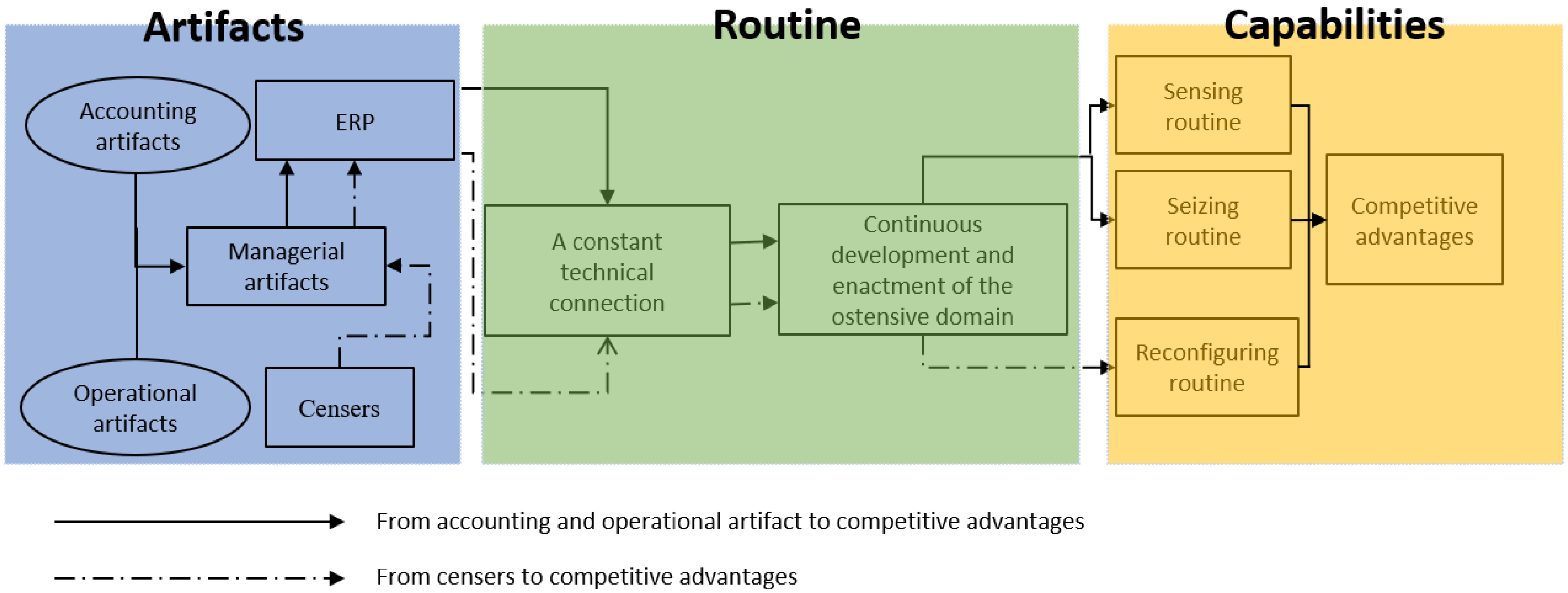
Table 5 Engineering data benefits

Rollins *et al.* (2012)	This sort of customer information [works] as organizational level information because it is about and from a buyer company to give feedback on products and services provided
Carr and Kaynak (2007), Krause and Ellram (1997)	Customers committed to supplier development are more apt to share information about product use, predicted future requirements, and proprietary information than are companies not involved in supplier development
Salvato (2009), **Tripsas (2009)**, **Augier and Teece (2009)**	Primarily through information-processing capabilities, the company is enabled to identify the nature of the changing market environment and sense opportunities

Table 6 Summary of a more profound understanding of the connection

Key points	**Descriptions**
The importance of the connections within the routine	•As the business develops rapidly, the need to reduce the communication distance is as essential as reducing the physical distance between the company, customers and suppliers; •Also, the necessity to reduce the communicational distance emphasizes the role of the artifact connection in the situated action.
The connection is temporary and only be stable in particular situations	•Artifacts, due to the IT upgrade, are differentiated and varied to meet the increasingly complex needs of management control in a hyper-competitive environment; •The development of the company is with enlargement of size and increasing volume and complexities of transactions and processes; •Subsequently, then, more data and information are produced and communicated, and thus, sophisticated IT is needed to make them connected and integrated.
The intriguing strategic advantages to be built via the use of ERP and MCS	•Several stages with a lengthy process are needed to develop dynamic capabilities; •During the process, the artifacts supporting the enactment of MCS are always being developed with IT upgrade; •Otherwise, the routine and the performance would be negatively affected severely by the incapabilities of MCS and ERP.
Artifacts to carry out the sub-ostensive aspects of various kinds	•Different artifacts carry out different data and information to visualize the space; •Artifacts of various kinds are produced because of the distinction between the sub-ostensive aspects.

Diagram 8 Artifacts, routine, and capabilities



Chapter 4. Visibility, recognizability, controllability and the quest for resource reconfiguration: the implications of management control and enterprise resource planning systems

4.1 Introduction

This second empirical chapter investigates how the post-upgrading of ERP impacts MCS configurations and reconfigurations and how the ERP-based MCS configurations and reconfigurations enable resource reconfiguration (RR).

RR rapidly responds to fleeting opportunities and urgent threats (Dixon *et al.* 2014 ; Helfat *et al.* 2007; Moliterno and Wiersema 2007; Sirmon and Hitt 2003; Yiu and Lau 2007). RR enables companies to develop superior performance through addition, deletion, or movement of resources (Karim 2006; Karim and Mitchell 2004), promoting the distinctive accumulation of organizational resource bases (Capron and Mitchell 2009; Das and Teng 2000; Hennart and Park 1993; Kale and Singh 2007; Karim and Mitchell 2000), or making incremental changes within existing organizational principles (Girod and Whittington 2017).[66]

According to existing research, ERP-based MCS could affect RR. In practice, ERP embodies the interdependencies of individual control practices (e.g., Chapman 2005; Gargeya and Brady 2005; Lodh and Gaffikin 2003; Olson *et al.* 2013; Ruivo *et al.* 2015). Subsequently, MCS could configure a company's idiosyncratic processes and resources (e.g., Eisenhardt and Martin 2000; Ferreira and Otley 2009; Frezatti *et al.* 2011; Henri

[66] The author claim that, "Restructurings involve fundamental change in organizational principles and are typically irregular" (p. 1121).

2006; Mundy 2010; Teece *et al.* 1997). Through a distinct information-based routine with integrated controls (e.g., Dechow and Mouritsen 2005; Henri 2006; Malmi and Brown 2008; Simons 1994), ERP-based MCS is associated with integrated controls over the entire business processes and customized analytics and reporting for strategic implementation (e.g., Chen *et al.* 2008; Granlund and Malmi 2002; Scapens and Jazayeri 2003; Sher and Lee 2004). On the other hand, Wagner *et al.* (2011) point out that technologies-in-practice are an inevitable part of the change. Old digital technologies (e.g., those ERP systems studied by MCS-ERP literature ten years previously) may not be sufficient to enable RR.

However, little is known about how the present ERP technologies and MCS configuration affects RR in specific ways. In practice, ERP and MCS are not merely general terms. Their functions, mechanisms, and performance effect differ depending upon how they are used in practice. The increasing trend of digitalization makes this research gap interesting and important, especially for China.[67] A company is digitalized to integrate nearly all of the organizational controls and to promote timely decision-making. The digitalization-based control and decision-making processes encourage a company to deal with the heterogeneity of resource types and their interdependencies, thus enabling them to compete within a structure supported by technologies, data, and information (e.g., Bortolini *et al.* 2020; Bouwman *et al.* 2019; Jennings and Stadler 2015; Li *et al.* 2017a; Wan *et al.* 2018). This chapter bridges this literature gap by discussing how the post-upgrading of ERP affects MCS configuration and reconfiguration of material resources in the case company's single-core production area.

This focused functional area is key to lowering costs, increasing turnover, and improving service (e.g., Fiestras-Janeiro *et al.* 2011; Handfield 1993; Jones and Riley 1985; Yuthas and Young 1998), but involves increasingly hyper-dynamic and

[67] China views digitalization as an organizational transformation strategy that enables economic corner-overtaking.

competitive actions that challenge decision-making and control practices (e.g., Bailey and Helms 2007; Ballou *et al.* 2000; Oliver and Holzinger 2008). These actions induce increased interdependency,[68] leading to increased uncertainties in decision-making and complexities in control (e.g., Colvin and Maravelias 2011; McLain 2009; Thompson 2003). They also require greater and more widely spread use of MCS for decision-making and control (e.g., Abernethy and Chua 1996; Alvesson and Kärreman 2004; Flamholtz *et al.* 1985; Gerdin 2005; Perera *et al.* 1997). For this to occur, a number of MCS practices have to be reconfigured when necessary (Bedford *et al.* 2016; Gerdin 2005; Hammervoll *et al.* 2012; O'Grady and Akroyd 2016; Quattrone and Hopper 2005).

Wagner *et al.* (2011) recognize the importance of studying the ERP modifications (e.g., ERP upgrade) to advance the MCS-ERP literature. This chapter therefore also considers the necessity of studying the configuration of a set of MCS techniques to avoid erroneous conclusions that result from studying specific MCS techniques in isolation (e.g., Bedford *et al.* 2016; Chenhall 2003; Grabner and Moers 2013; Malmi and Brown 2008; Otley 2016). However, in practice, the post-upgrading of ERP is not straightforward and would create further challenges in promoting MCS reconfiguration (e.g., Boudreau and Robey 2005; Dechow and Mouritsen 2005; Kallinikos 2004; Quattrone and Hopper 2005; Robey *et al.* 2002).

Drawing on Malmi and Brown's (2008) perspective of studying MCS as a package, this chapter looks at the combinative use of MCS practices to analyze the MCS reconfigurations in the context of RR. Malmi and Brown's (2008) perspective helps to identify five main MCS techniques: planning controls, cybernetic controls, administrative controls, cultural controls, and incentive and compensation controls (for a definition of these controls, see Table 7).

Identifying these five techniques helps to realize the interdependencies of each

[68] Thompson (2003) identified three patterns of interdependencies—pooled, sequential, and reciprocal—each associated with its own degree of information handling complexity.

individual MCS technique during resource allocation.

In this chapter, I observed how planning, cybernetic controls, and administrative controls were used interdependently (for details of the MC practices observed, see Table 11 Examples of the action planning, working procedure, organizational structure, and hybrid measurement systems that were based on ERP) to solve control problems of varying levels. Malmi and Brown's (2008) perspective also helps to focus on the distinction between decision-making and the controls function of MCS. This distinction allows this study to capture the complete function of individual MCS practices in a particular configuration. Finally, Malmi and Brown's (2008) perspective helps to identify the need for MCS modification or changes by linking any MCS practice with broader MCS practices. In other words, their perspective is useful for identifying the MCS techniques in the ERP-based MCS configuration and how they are modified in the MCS reconfiguration.

Adopting the notion of studying MCS as a package, this chapter reveals that the ERP-based MCS changes that promote material resources-related actions lie within three configuration forms: the basic, intermediate, and advanced forms. The three forms, which are based on Bedford's (2020) category of management control packages with varying interdependencies,[69] describe how MCS techniques are configured and reconfigured to cope with different levels of complexities of resources and actions. Each form also produces varying levels of visibility, recognizability, and controllability of material resources and related actions, leading to different methods of resource reconfiguration.

I use the concept of *the basic form* to describe how two or three management control practices work interdependently to solve problems that occur in the movement of single resources, such as how a single material resource (e.g., component) is appropriately

[69] They are package with no extensive, package with little interdependence, package with moderate interdependence, and package with moderate interdependence.

used in multiple designs and production without having to re-create it in each assembly or production file. *The intermediate form* describes how three or four management control practices work interdependently to solve problems that occur in the movement of any group of resources, such as the overhead control problem. *The advanced form* describes how four or five management control practices work interdependently to solve problems that occur in the changes that emerge in the movement of any group of resources, such as how to deal with a sale order change when the sale order is being processed with other sale orders.

Additionally, based on the three forms, this chapter recognizes the importance of the dynamic fit between structural rigidity and functional flexibility of ERP in maintaining effective MCS reconfiguration and control outcomes for reconfiguring resources. In this way, MCS can maintain and alter organizational action patterns to stabilize the company while preventing radical modification of existing principles in dynamic conditions.

This chapter makes three contributions. First, it empirically contributes to the MCS-ERP literature by providing initial evidence on the impact of structural rigidity and functional flexibility of ERP on enabling various MCS configuration forms. Such new evidence also implies that MCS and ERP that work together in dynamic conditions may be sensitive to the fit between structural rigidity and the functional flexibility of ERP. This evidence is important in order to update the MCS-ERP literature, because existing studies that are primarily based on relatively stable conditions do not reckon with the emergent IT infrastructure and MCS changes that serve to stabilize a company's operation in dynamic conditions. The evidence could also suggest that future MCS-ERP studies embrace the multiple aspects (e.g., structural vs functional) of ERP and how each aspect affects MCS integration.

Second, this chapter contributes to Malmi and Brown's (2008) theoretical framework by clarifying how individual MCS techniques are configured and reconfigured. This incremental contribution is important because it theoretically contributes to the limited but essential understandings of how multiple MCS techniques are actually configured and reconfigured in a company (e.g., Bedford *et al.* 2016; Malmi and Brown 2008; Otley 2016; Sandelin 2008). Not only does it confirm the existence of the combinative form of MCS techniques in the case company, but also it indicates that ERP might be critical in realizing the combinative form of MCS practices. Additionally, ERP-adopting companies might rely on the coexistence of multiple MCS configurations. This understanding could suggest that the future studies that are based on Malmi and Brown's (2008) framework consider, first, the multiple instead of the single MCS configurations and second, technology-in-use that might make the MCS configurations differ.

Third, identifying three MCS configuration forms offers practical insights into accounting digitalization as an area that challenges the current accounting practice (Bhimani and Willcocks 2014; Quattrone 2016). The three forms of MCS configurations allow us to capture how the MCS configuration is constructed in terms of visibility, recognizability, and controllability, and how the configuration varies across various levels of action dynamics and complexities. Such three forms broaden the scope of MCS practices by producing visibility by numbers and reporting, to offering decision alternatives using analytics via digitalized means.

The remainder of this chapter is divided into five sections. The next section (Section 4.2) provides a literature review to demonstrate how the existing research perceives the impact of the post-upgrading of ERP on MCS reconfiguration and how the resulting impacts enable RR. Section 4.3 illustrates how Malmi and Brown's (2008) perspective is implemented. Section 4.4 deals with the context of the material resource allocation and optimization practices at SunPlants. The fifth section (Section 4.5) presents the case findings, while Section 4.6 discusses the research findings, offering possible implications. This chapter concludes with Section 4.7 highlighting the limitations of the study and suggestions for future research.

4.2 Literature review

This section describes how the existing literature perceives the effect of ERP on MCS configuration and reconfiguration and how the ERP-based configuration and reconfiguration enable RR. Last, it shows how little is known about the ongoing MCS reconfiguration in the digitalization age.

4.2.1 The effect of ERP on MCS configuration and reconfiguration

This section shows why ERP in offering digitalized context affects MCS configuration and reconfiguration, and how ERP as a concrete means may affect MCS configuration and reconfiguration. This section also indicates the socio-material nature of the ERP-based configuration and reconfiguration and its difficulties and complexities.

First, ERP affects the MCS configuration and reconfiguration because ERP digitalizes the context within which MCS enacts and develops (e.g., Howard-Grenville 2005) in terms of structure, information supply, and integration mechanism (i.e., platform). Granlund and Malmi (2002) find that ERP changes the broader structure in which MCS enacts and develops. This structure changes because ERP changes responsibilities by modifying an organizational form.[70] ERP enriches the information supply by offering various sources and uses of information to keep the business strategies implemented effectively (Huang *et al.* 2004; Huang and Handfield 2015; Kelle and Akbulut 2005; McKee *et al.* 1989; Ptak and Schragenheim 2003; Tan and Litschert 1994). ERP also builds a unique platform for MCS, communicating and maintaining new strategies, while MCS enactment involves numerous controls to align individuals' actions with organizational goals (Abernethy and Chua 1996; Alvesson and Kärreman 2004; Flamholtz *et al.* 1985; Otley 1980; Simons 1994). This uniform platform helps the company to integrate numerous controls for new strategies (e.g., Baden - Fuller and Winter 2008; Jacobs and Bendoly 2003; Liang and Xue 2004; Simons 1994; Xue *et al.*

[70] ERP changes responsibilities by modifying an organizational form consisting of pure business units specializing in a particular type of products into a company that makes various types of products in most business units.

2005). In other words, for the MCS configuration and reconfiguration, ERP renews the links between organizational strategy, organizational structure, and digitalized forms of MCS functions.

Second, ERP is a digital means for MCS configuration and reconfiguration. ERP carries this out through digitalizing standardized operating procedures, checklists, templates, and other written documentation (e.g., Benders *et al.* 2006; Gattiker and Goodhue 2004; Granlund and Malmi 2002; Nandhakumar *et al.* 2005; Scapens and Jazayeri 2003). Scapens and Jazayeri (2003) note the difference between ERP setting parameters of a generic set of MCS techniques (configuration) and ERP altering that set of MCS techniques (reconfiguration).[71] MCS configuration and reconfiguration occur to meet changing business needs. Bhimani and Willcocks (2014, p. 470) also recognize that digitalization is altering MCS in terms of reporting, analysis, and decision-making, through the changing relationship between data, information, and knowledge of MCS.[72]

Third, ERP-based configuration and reconfiguration qualify as a socio-material practice. Most qualitative MCS-ERP studies draw on a socio-material perspective, including the Actor-network theory (e.g., Dechow and Mouritsen 2005; Hyvönen *et al.* 2008; Quattrone and Hopper 2005) and practice theory (Wagner *et al.* 2011). This research stream offers new and exciting insights into accounting changes by not giving the human or the ERP technology primacy in the analysis a priori (e.g., Gaskin *et al.* 2014; Wagner *et al.* 2011). Based on this socio-material perspective, ERP imposes a strong "techno-logic" on a company to affect MCS configuration and reconfiguration (Dechow and Mouritsen 2005). Subsequently, MCS configuration and reconfiguration seem to reproduce existing organizational reality (Granlund and Malmi 2002; Hyvönen

[71] The authors (p. 208) state: "Whereas configuration entails setting the parameters of the generic package, customization involves altering that package… A generic copy of SAP usually provides the starting point for customization."

[72] The authors believe that (p. 471): "One conception of linkages between data, information and knowledge is to regard data as a record, information as message and knowledge as a model (of how something works)."

et al. 2008; Wagner *et al.* 2011). Venters *et al.* (2014) reveal that the change in digital infrastructure (e.g., ERP) would lead to an "unstable and evolving socio-material configuration" (p. 931), where multiple configurations exist (e.g., Barrett *et al.* 2016; Cecez-Kecmanovic *et al.* 2014; Demetis and Lee 2017; Gaskin *et al.* 2014). This stream of studies also reveals that MCS configuration and reconfiguration confronts difficulties and complexities that are increased due to new relationships between actors and the new situation(Hyvönen *et al.* 2008).

Similarly, studies adopting other theoretical and methodological perspectives suggest the importance of understanding (re)configuration (Scapens and Jazayeri 2003) and contexts (Chapman and Kihn 2009; Granlund and Malmi 2002; Xiao *et al.* 2011) in the MCS-ERP research.

In summary, the MCS configuration and reconfiguration involve a reasonably complex organizational process and strong technological and organizational path dependencies at multiple levels, with unclear organizational outcomes (Dechow and Mouritsen 2005; Quattrone and Hopper 2005; Scott and Orlikowski 2014; Wagner *et al.* 2011). RR may be a starting point to examine the outcomes. The next section depicts the relationship between RR and MCS.

4.2.2 MCS and RR

RR links MCS practices within the context of rapidly changing environments (Teece *et al.* 1997). Eisenhardt and Martin (2000) demonstrate that a long-term strategic advantage does not rely on DCs themselves but on the RR created. Since the 1980s, MA research has focused on the strategic impact of MCS (e.g., Bromwich 1990; Govindarajan and Gupta 1985; Simons 1987). Although there is no direct evidence regarding the relationship between MCS and RR, most of the existing resource-based view (RBV) research gives implications for MCS's potential impact on RR. Based on the existing RR literature, I review the literature on how MCS relates to RR from these three perspectives.

First, MCS is involved in the resource-focused processes or actions involved in RR. RR consists of a series of actions to help companies develop a more efficient way to maximize the value of organizational resources and capabilities (Helfat *et al.* 2007; Moliterno and Wiersema 2007; Sirmon and Hitt 2003). Various MCS techniques (e.g., Chenhall 2003) are involved in various actions and processes associated with RR (e.g., Henri 2006; Mundy 2010; Simons 1990). MCS helps companies to distinguish between core organizational actions and non-core organizational actions (e.g., Birkin 2000; Cooper and Kaplan 1991; Smith *et al.* 2005; Suddaby *et al.* 2009) and identify the conditions in which the core actions create competitive advantages (Bowman and Toms 2010; Bromwich 1990; Cunningham 1992; Kaplan 2006). In other words, the involvement of MCS in actions and processes is critical to developing RR.

Second, MCS supports companies in changing the resource bases (Simons 1990). Hansen et al.'s (2004, p. 1280) empirical results led them to "conclude that what a company does with its resources is at least as important as which resources it possesses". The resource base of a company per se is not sufficient to create a sustainable competitive advantage (Barreto 2010; Easterby - Smith *et al.* 2009). What is important is that companies are encouraged to change (e.g., create, extend, or modify) their resource base to deal with market change and create a competitive advantage (Eisenhardt and Martin 2000; Helfat *et al.* 2007; McKelvie and Davidsson 2009). Through MCS, the company can facilitate motivating, monitoring, measuring, and sanctioning managers' and employees' resource-related behavior and actions (Macintosh and Quattrone 2010).

Besides, Brush *et al.* (2001, p. 64) point out that, "Strategies for attaining competitive advantages emphasize developing and configuring existing resource strengths into a valuable and unique resource base". MCS is essential in developing and configuring existing resource strengths, such as the use of Activity-based Cost Management (ABCM) and integrated cost systems (Cooper and Kaplan 1998), target costing (Ansari *et al.* 2006), and life cycle costing (Berliner and Brimson 1988). In this way, MCS encourages managers to change resource bases for new strategic initiatives (e.g., Barney 1991; Dutton *et al.* 1997; Henri 2006; Kanter 1984; Marginson 2002). In other words, MCS is necessary and useful for RR when MCS is used for changing the resource base of a company.

Third, the RBV implies that various MCS configurations lead to different forms of RR. Yi *et al.* (2016) demonstrate that the company is characterized as a configuration of interdependent actions and resources. The reconfiguration helps adapt to cope with environmental challenges. The reconfiguration occurs at every level, including reconfigurations of MCS (e.g., Malmi and Brown 2008; Otley 1980), actions, and resources (e.g., Pentland *et al.* 2012; Teece *et al.* 2016). The full value of resources for creating competitive advantages is realized when resources are reconfigured effectively (Sirmon and Hitt 2003; Sirmon *et al.* 2007).

Marginson (2002, p. 1019) implies the importance of the use of MCS in RR, by emphasizing that, "understanding the effects that MCS have on managers' strategic activities is becoming imperative… such knowledge will help firms develop more effective MCS to 'steer' the development of strategy and thereby secure desired strategic outcomes". Perhaps Marginson suggests reconfiguring MCS to make it more effective. RR's role and change in resource base are strategically significant for the company (Brush *et al.* 2001). When the external environment is dynamic, the reconfiguration of a set of MCS practices will enable the reconfiguration of organizational actions and resources (e.g., Bedford *et al.* 2016; Malmi and Brown 2008; O'Grady and Akroyd 2016; Sandelin 2008). Furthermore, various MCS techniques may be reconfigured to encourage managers to reconfigure the actions and resources (Brown *et al.* 2020; Nuhu *et al.* 2019; Peters *et al.* 2019), decrease resource deficiency, and generate new resource applications (DeSarbo *et al.* 2005; Kogut and Zander 1992; Teece *et al.* 1997).

RR has different forms[73] (Krasnikov and Jayachandran 2008; Liu *et al.* 2018; Mao *et al.* 2016; Prašnikar *et al.* 2008; Song *et al.* 2005; Song and Thieme 2006) within particular periods (Saranga *et al.* 2018). Additionally, no unique MCS (re)configuration could be built to benefit them all. Improper MCS (re)configurations would lead to wasted resources, instability, and ultimately, slower decision-making and lower performance in resource-related actions and processes (Bisbe *et al.* 2007; Henri 2006; Mundy 2010). In other words, MCS must be effectively reconfigured to promote RR in continuing to create changes in the resource bases and sustainable competitive advantages.

4.2.3 Summary

This section shows the extant knowledge concerning how ERP functions as a role of both constructing the digital context and as a concrete means of MCS reconfiguration, indicating the possible ways in which MCS reconfiguration may affect the operation of RR actions, the mobilization of resource base change, and the materialization of RR form changes. ERP-based MCS practices are also beyond merely performing operational actions and using the resource to achieve efficiency, but more about developing new ways to transform the operational to the strategic without radical changes in the existing resource base. In other words, existing research implies the way to trace the relationship between ERP, MCS configuration and reconfiguration, and RR in the digitalization age, but further efforts are still needed.

However, a research gap emerges: how MCS and ERP continue to create unique resource bases and competitive advantages is still unclear. In other words, we know that ERP affects MCS configuration and reconfiguration, but we do not know their ongoing interactions. This gap is interesting for two reasons. First, the existing research rarely

[73] Scholars have addressed various kinds of RR such as the complementary configurations of technological and marketing resources (Krasnikov and Jayachandran 2008; Liu et al. 2018; Mao et al. 2016; Prašnikar et al. 2008; Song et al. 2005; Song and Thieme 2006), marketing and innovation resources (Mao et al. 2016).

empirically studies the totality of an overall MCS until Ferreira and Otley's (2009) and Malmi and Brown's (2008) works in 2008. Although it is imperative to know how multiple MCS techniques configure and work simultaneously to reach effective control outcomes (e.g., Bedford 2015; Grabner and Moers 2013; Kennedy and Widener 2008; Malmi and Brown 2008; Sandelin 2008), most of their works are primarily analytic, addressing some implications for empirical studies (Bedford *et al.* 2016; Otley 2016). Otley (2016) suggests that there is scope for empirical inquiries to complement their analytic results. Moreover, MCS could not be studied independently of technologies (Dechow and Mouritsen 2005); hence, capturing the ERP-based MCS configuration and reconfiguration becomes meaningful.

Second, ERP-based MCS configuration and reconfiguration are company-specific, strategy-specific, and resource-specific. For example, an SME manufacturer with a cost-effective strategy dependent upon physical and material resources must have a different ERP system to a large service company with more non-physical resources. Contingency-MA research suggests that there would be no one unique (best) MCS configuration form, and the performance effect of any MCS configuration form is a context-specific performance effect (e.g., Abdel-Kader and Luther 2008; Chapman 1997; Chenhall 2006; Gerdin *et al.* 2019; Otley 1980; Otley 2016). According to existing MCS research, the combinative use of MCS is used to effectively reconfigure organizational resources based on multiple specific strategic goals (e.g., Bedford *et al.* 2019; Sundin and Brown 2017), which also applies to the ERP-based MCS configuration. Hence, studying how specific ERP-based MCS reconfiguration leads to specific RR has strategic meaning.

This chapter, therefore, bridges this research gap by focusing on how a context-specific ERP upgrade enables specific MCS configuration and reconfiguration to contribute to context-specific RR. This chapter studies the ongoing interaction by focusing on how ERP supports configuring and reconfiguring individual MCS techniques in reconfiguring material resources. The next section demonstrates how this chapter employs Malmi and Brown’s (2008) perspective to provide a complete understanding of the range of effective MCS configurations available to companies in a given context, thus, examining the strategic impact of effective control outcomes.

4.3 Conceptual framework

This section draws on Malmi and Brown’s (2008) perspective of studying MCS practices as a package, and related research ideas based on Malmi and Brown’s (2008) perspective (e.g., Bedford (2020)). Existing MCS research has pointed out that exclusively studying MCS’s specific uses has resulted in an unfortunate ambiguity regarding the exact meaning and implications of MCS (Grabner and Moers 2013). MCS research has been attempting to explore new ways of using MCS practices, especially the ways of not using MCS practices in isolation (Bedford *et al.* 2016; Grabner and Moers 2013; Malmi and Brown 2008; Sandelin 2008).

Some existing studies have indicated the benefits of studying a set of MCS. For example, O’Connor *et al.* (2011) find a positive association between the competitive forces and the importance that the companies place on the set of MCS practices[74] (i.e., formal procedures, strategic planning, budget targets, approval procedures, and participative budgeting). O’Grady and Akroyd (2016) identify two dimensions to evaluate the MCS practices in terms of the completeness and effectiveness of MCS.[75] Bedford *et al.* (2016) indicate that prospector firms can benefit from the combinative use of the

[74] The positive associations show two various patterns. The first pattern is that a positive association exists between the threat of foreign entrants and the importance that the companies place on their MCS, but this association is larger for companies competing predominantly in the domestic market than for those competing predominantly in international markets. The second pattern is that the association between buyers’ bargaining power and the importance that the companies place on their MCS is larger for companies competing predominantly in international markets than for those competing in domestic markets.

[75] The findings reveal that the components of the system are complete, and therefore control problems arising from incomplete structures are not anticipated or found. Also, the effectiveness of the system can balance the variety of the system and offer processes that amplify branch managers’ ability to respond to highly uncertain external conditions.

interactive use of MCS and organic structural controls.[76] Sundin and Brown (2017) reveal that a practical set of MCS practices effectively manages organizational tensions.

Malmi and Brown's (2008) perspective extends the idea of the combinative use of MCS practices. The combinative use of MCS practices has lasted for over 40 years (Otley 1980), and regular calls have been made to study the phenomenon (e.g., Chenhall 2003; Dent 1990; Flamholtz *et al.* 1985; Malmi and Brown 2008; Otley 1980). ERP has made the combinative use of MCS possible, as it becomes a means to package relevant MCS techniques together as an open system. This chapter adopts Malmi and Brown's (2008) perspective in three ways: how to separate the empirical MCS practices analytically, and two ways for the MCS to be analyzed and studied as a package.

[Insert Table 7 here]

First, Malmi and Brown's (2008) perspective offers five control types: planning controls, cybernetic controls, administrative controls, cultural controls, and incentive and compensation controls (for a definition of these controls, see Table 7). In practice, multiple MCS techniques work simultaneously in a combinative form within a company (Bedford 2015; Kennedy and Widener 2008; Malmi and Brown 2008; Sandelin 2008). Such five analytical concepts help to clarify which single MCS techniques combine to be configured through the ERP, those that are not configured in the ERP, and how to assess its fundamental effect.

Moreover, Malmi and Brown's (2008) perspective suggests that ERP-based MCS practices studied have incremental benefits in isolation that may not necessarily be relevant for achieving effective control outcomes when analyzed as part of the broader

[76] Prospector firms refer to those with a competitive strategy that emphasizes product innovation and the search for new market opportunities. The interactive use of MCS focuses attention and forces dialogue throughout the organization, which is used to stimulate organizational learning and the emergence of new ideas and strategies. Organic controls involve creating slack resources, self-contained tasks, vertical information systems, and lateral relations.

set of MCS practices that a firm has in place (Bedford *et al.* 2016). Accordingly, this chapter deals with the complexities of ERP-based MCS practices by examining how the functioning of individual controls be dependent on other controls being enacted simultaneously to solve particular control problems (Grabner and Moers 2013). Also, Bedford (2020) sheds light on the varying interdependencies of management control packages (i.e., those with no extensive, those with little interdependence, those with moderate interdependence, and those with extensive interdependence).

Second, Malmi and Brown's (2008) perspective emphasizes the distinction between decision-making and the controls function of MCS. Decision-making involves choosing the correct solution from amongst a number of alternatives (e.g., Keeney 1996; Morente-Molinera *et al.* 2017; Nutt 2004; Zanakis *et al.* 1998). Controls comprise "a combination of control mechanisms designed and implemented by management to increase the probability that organizational actors will behave in ways consistent with the objectives of the dominant organizational coalition" (Abernethy and Chua 1996, p. 573).

This distinction supports this chapter to develop a complete explanation of the scope of ERP-based MCS configuration and reconfiguration. This helps identify if a single MCS could be called an MCS-in-use. For example, as a particular MCS, planning should accomplish two tasks, which are supporting ex-ante decision-making and creating goal congruence (i.e., control) within a company; otherwise, such planning would not be labelled as a MCS (Malmi and Brown 2008).

Third, Malmi and Brown's (2008) perspective helps to identify the need for MCS reconfiguration (i.e., modification or change) (Chenhall 2006). Malmi and Brown's (2008) perspective suggests studying broader MCS practices, the mechanisms of MCS change, and the implementation of modified forms of MCS within a much more dynamic context than previously (e.g., Bedford *et al.* 2019; Bedford *et al.* 2016; De Jong *et al.* 2014; Gerdin *et al.* 2019; Grabner and Moers 2013). Hence, Malmi and Brown's (2008) perspective helps to identify the change needed by linking the particular MCS change with the change's relation to a broader control mechanism that shapes organizational action integration, resource deployment, and capability development.

In summary, Malmi and Brown's (2008) perspective helps to focus practically on the factors associated with MCS (i.e., decision-making and control), thus preventing a focus on single control practices that result in underspecified models (Chenhall 2003; Grabner and Moers 2013) and reporting spurious findings (Chenhall 2006).[77]

However, it is not completely clear how a set of MCS practices (i.e., a configuration form) are good or bad. A particular configuration form's effectiveness should be evaluated within the company's context (Bedford *et al.* 2016; Sandelin 2008). Studying the MCS as a package requires more effort to understand how to create both the MCS's design and operation within a particular context (e.g., Bedford *et al.* 2016; Grabner and Moers 2013). This chapter demonstrates the change from multiple key dimensions rather than merely the change form (Busco *et al.* 2007). In other words, this research must go beyond the MCS change form.

The next section offers case findings concerning the MCS configuration forms that vary in RR contexts and MCS reconfiguration characteristics.

4.4 Resource allocation and optimization practices at SunPlants

This section provides an overview of the resource allocation and optimization practices at SunPlants. At SunPlants, there are 10,000 different material types in total. Besides, such an amount of material resources and their relevant information are transferred to all SunPlants departments to meet the delivery of a particular product. They are transferred through design, planning (inventory-based), procurement, warehousing, and

[77] Chenhall (2006) gives an example: a study focused only on formal budget systems may argue that they are unsuitable in uncertain operating conditions as they include incomplete information and lack flexibility, but this study may ignore that they are systematically combined with open and flexible informal communications between managers. This unexpected finding occurs as a consequence of limiting the study to budgets without considering broader control and information networks.

production actions and processes.

SunPlants' products are mainly customized, in conjunction with the "manufacturing to order" mode. Once the marketing center has signed the agreement and entered the relevant information, ERP sends production orders to the production department. Subsequently, the R&D department develops customized and professional products in accordance with the contract and generates a BOM in the ERP. Such BOM contains the list of material resources in the product designed by engineers, including the items, parts, components, sub-assemblies, and assemblies.

The production planning department uses the ERP to perform comprehensive calculations based on the BOM and actual inventory conditions to generate a material requirement plan. A material requirements plan is a planning and decision-making tool used in the production process that analyzes current inventory levels and production capacity, as well as the need for manufacturing assets. The plan specifies the necessary materials, their quantities and the time when they are needed. Inadequate inventory and inaccurate inventory information will result in an inaccurate plan, resulting in production line interruptions and the inability to meet delivery deadlines.

Materials to be procured or outsourced in the material requirements plan will be transferred to the supply chain management centre for price review. After the price review is completed, the ERP will generate a purchase order and transfer it to the purchasing department for purchase or outsourcing. For the company's self-made materials, ERP generates a production order and transfers it to the production department for execution. Purchased and outsourced materials will be placed in the warehouse after completion of the acceptance inspection.

Then, the production department receives materials (e.g., Parts and components) from the warehouse to produce the equipment according to the drawings' requirements. In the ERP, each product has particular financial accounts for accounting material costs, direct labor, and manufacturing overheads. The confirmation and costing of each product are complete and in compliance. The cost allocation method is accurate, which may be an accurate indication of the actual cost of each product produced.

Notably, SAP plays a critical role in transferring material resources and their relevant information. In particular, SAP enables SunPlants to clarify six main types of (master) data[78] for managing SunPlants' material-related actions. They are material master data, vendor master data, purchase info data, source list data, quota arrangement data, and service master data.[79] This data classification allows SunPlants to manage vendors, procurement process, inventory process, pricing process and materials.

On the basis of this data basis, SunPlants streamlines and coordinates various aspects of decision-making[80] and controls[81] over the business and operation of allocating material resources, such as procurement process, (master) data, material valuation, inventory management, invoice verification, and material requirement planning. It brings some advantages to SunPlants like the following.

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[78] Master data is referred to in different transactions, and examples are customer, product, or supplier data. Generally, master data does not change and does not need to be created with every transaction. Transactional data relates to the transactions of the organization and includes data that is captured, for example, when a product is sold or purchased. For example, if one customer purchases multiple products at different times, a transaction record needs to be created for each sale, but the data about the customer stays the same.
(details see: https://www.sciencedirect.com/topics/computer-science/transactional-data)

[79] In SAP, material master data contain the information of a material that an organization purchases, manufactures, and sells a product. Vendor master data contains the information about vendors – address, financial data, payment terms, purchasing data like currency, order value. Purchase master data is a combination of material master data and vendor master data, which consists the detailed information about materials and vendors supplying the required materials. The source list is a type of master data that determines the source of supply for a material, which lists the preferred sources from which the material can be procured. Quota arrangement is a method that determines the part of the materials that can be procured from a specific source. Quota arrangement divides the total requirement of material among positive resources of vendors and then assigns quota to every vendor. This specific quota specifies the portion of material that is to be procured from the assigned vendors. Service master data records all the details about the services procured from the vendor or service contractors are stored.

[80] For example, strategic, tactical, and operational (Schmidt and Wilhelm 2000).

[81] For example, result controls, action controls, personnel controls, and cultural controls (Merchant and Van der Stede 2007, p. 76).

Firstly, SAP helps SunPlants to significantly reduce its capital commitment by purchasing on a just-in-time basis while ensuring no shortage of materials throughout the product delivery process. Second, SAP helps SunPlants speed up material management and procurement actions. This ensures that the required material is available at the right time, in the right place, and in the required quantity and quality, allowing material resources to be reconfigured as needed. Third, SAP helps SunPlants accelerate productivity and reduce costs while maintaining accommodations for frequent changes in a business environment. The largest beneficiary is most SunPlants' managers involved in the material movement process. SAP enables the managers to easily see the material situation, locating where the problem is, and performing excellent analysis before decisions and control are made in purchasing, inventory, pricing, and material resources allocation.

In summary, SAP plays a critical role at SunPlants' material resource allocation and optimization practice. SAP-based resource allocation and optimization are based not only on clear and transparent data structures but also on streamlined material movement procedures. Both the data structures and the procedures work together to make effective decision-making and control for reconfiguring material resources. While we can see the significant benefits of SAP in allocating and optimizing SunPlants resources, the process is challenging. The following section describes how hard and energetic this process has been over a period of time.

4.5 Case analysis and findings

This section consists of three main subsections to investigate how the post-upgrading of ERP impacts MCS configurations and reconfigurations and how the ERP-based MCS configurations and reconfigurations enable RR. By focusing on material-related actions, it presents three major ERP-based MCS configuration forms (i.e., the basic, intermediate, and advanced (see Table 12)). Different MCS configuration forms are constructed by different and specific upgraded ERP functions, producing different levels of visibility, recognizability of material resources and organizational actions.

Such three subsections work together to bridge the research gap[82] by exploring how particular MCS configuration forms and specific ERP functions work together to create unique resource bases and competitive advantages. The first subsection shows how the post-upgrading of ERP enables MCS to reproduce visibility and recognizability that are recognized as essential in developing RR. The second subsection examines how the the basic and intermediate forms of MC configuration forms are enabled by some specific upgraded ERP functions to produce visibility and recognizability, contributing to capturing individual resource and action elements, accounting the resources and actions under movement, and digitalizing linkages of resources and actions. The third subsection describes how some specific upgraded ERP functions enable the MCS to be reconfigured in a more complex form, capable of digitalizing and capturing resource and action changes, mobilizing cross-functional or departmental actions maintaining production efficiencies and long-term benefits.

4.5.1 *Characteristics of MCS configuration for RR*

This section outlines how two main characteristics of MCS configuration (i.e., visibility, and recognizability) emerge from the particular mix of ERP (before and after the upgrade), organizational actors, and the RR context.

4.5.1.1 Visibility

The effect of ERP on MCS depends upon whether or not the resources and actions within space are visible in the ERP. When ITs are adopted, resource visibility is considered necessary (e.g., Delen *et al.* 2007; Zhang *et al.* 2015; Zhou 2009). The interviews conducted for this study suggest that visibility is the essence of accounting practices in order to penetrate more deeply into organizational space.

Effective ERP-based MCS requires that the resources and actions be visible in the ERP. Quattrone and Hopper (2005) believe that an information system is theorized as an

[82] That is, how MCS and ERP continue to create unique resource bases and competitive advantages is still unclear.

absence that establishes a presence by mobilizing and attracting other actors and technologies. According to Bhimani and Willcocks (2014), managers who do not visualize the single resources and actions item into the IS through their "datamation" could not enact the MCS via the IS.

At SunPlants, rapid business development in recent years has made managing material resources via ERP more complicated. ERP-based MCS practice is no longer as straightforward in practice. When using the old ERP, SunPlants faced a situation where there was impaired visibility:

> "There are too many materials in the storeroom… There are 100,000 types of total materials… The sorts of materials are constantly surging but without a timely update… [So] there were lots of material wastes." (R&D manager J)

When SunPlants was using the old ERP, the digitalized forms of principles, standards, rules, and procedures of conduct related to material resources failed to update as fast as the change took place, although such fast update is considered essential for on-going performance of organizational activities (e.g., Duhan 2007; Prusak 2009; Sveiby 2001; Teece 2000). This led to impaired visibility of resources and actions.

This impaired visibility was manifest in two aspects. First, in the face of SunPlants' rapid development, the digitalized forms of principles, standards, rules, and procedures of conduct in MCS to perform material-related actions became obsolete.[83] The old ERP did not help the MCS to effectively visualize the increased amount of material resources and action patterns via ERP. Second, not all of the material resources at SunPlants were managed in the old ERP. Instead, manually collected data sets still prevailed in the MCS practices. For any expert at SunPlants, managing material resources by hand-carried data sets was not easily achievable, even when all the resources were highly standardized and visualized. The impact was notable when the old ERP was present:

> "The information is not synchronized with real objects... [which] have been put into storage, but the information is still on paper… As more papers pile up, the outdated information will cause

[83] I have acknowledged that there are other forms of MCS (e.g., informal and cultural controls) that are not usually codified and digitalized.

serious problems in overhead and inventory controls." (Consultant Zh)

At that time of the old ERP, impaired visibility notably impacted inventory control and exacerbated the impact of notionally accurate accounting information on decision-making and control. The notionally accurate overheads and inventory information made the MCS practices unable to produce the correct operational actions (Barlev and Haddad 2003; Hopper and Armstrong 1991). With the old ERP, SunPlants' managers did not have sufficient data and information to monitor any particular material resources consumed by particular actions. It was also difficult and time-consuming to collect data and information when SunPlants' managers needed to monitor production progress, evaluate the processed outcome, and make corrections to the process. Subsequently, such MCS did not produce complete accounting inscriptions[84] that are believed critical (Robson 1992) to enable a traceable process (Robson and Bottausci 2018). An example is the self-made materials:

> "[In the old ERP time], the costs of self-made parts were calculated manually... [It requires the] automated calculation of self-made materials and components, and the cost allocation can be more accurate in this way." (PICO 3.2.1)

At SunPlants, the production process of one self-made material resource involved several kinds of material resources and material-processing actions. The impaired visibility and notionally accurate accounting information obscured the exact number of self-made materials. Thus, at SunPlants, the controls over self-made materials became problematic, as either the single actions or the action patterns were uncontrollable to a large extent.

In summary, the data and information collected by the old ERP exacerbated the already impaired visibility. This impairment caused SunPlants to be incapable of supporting MCS practices to develop RR. SunPlants' managers faced considerable difficulties using various MCS techniques to distinguish a particular material resource and action from other material resources and actions. Gradually, impaired visibility created

[84] The term inscription refers to the material and graphical representations that constitute the accounting report: writing, numbers, lists, tables (Robson 1992, p. 685).

confusion for those at the aggregate level or interdepartmental level, making it difficult for managers to understand the addition, deletion, or movement of material resources. Subsequently, SunPlants' individual managers faced difficulties in quickly modifying plans and cost targets to support RR.

4.5.1.2 Recognizability

In addition to data and information collection related to visibility, some MCS practices based on analytic methods, such as variance analysis, were abandoned at that time of the old ERP.[85] Such practices are more about recognizability that is necessary to manage actions related to material resources. When SunPlants used the old ERP, the recognizability was impaired. The interviews reveal that the recognizability is based on accounting practices by setting the accounts for overheads, materials, and labors, visualizing their costs, and matching them to the right resources and action categories. Since formal controls are often general and abstract for all of the situated actions, existing research reveals that variance analysis for the unacceptable outcomes is advantageous (e.g., Ford 1996; Peeters *et al.* 2014; Pentland *et al.* 2012; Yi *et al.* 2016; Zott 2003). The impaired recognizability manifested such that SunPlants could not effectively identify existing action patterns and failed to correct action patterns from the variance recognized.

However, the old ERP could not help to identify variance because the data and information did not provide sufficient samples. Insufficient and obsolete data and information caused managers to make incorrect decisions:

> "They said they [production managers] always "pat on the head" (pài nǎo ké)[86] and make decisions…" (Associated CEO QX of the vendor)

The unrecognizable action patterns led to the unreliable specification of accountability

[85] The analysis of factors contributing to the variance identifies and indicates if or not the cause of the variance is among the input of a specific material or the production actions wherein the incorrect operation of a worker or machine failure takes place.

[86] This Chinese vocabulary refers to subjective decision-making.

and responsibility. It took considerable time for SunPlants' managers to identify the problems before solving the problems. The interviewees said that when SunPlants was not using SAP, the managers often met and spent much time on identifying problems and differentiating accountabilities. During the meeting, the managers blamed others.

Organizational actions are often interdependent. During the production process, most single actions to process material resources are associated with other actions. Thus, any single problem is always connected with other problems. At SunPlants, the management team realized that problem-solving was more than solving a single problem for a single action. Instead, the interviews highlighted that problem-solving required the use of multiple MCS practices. For example, managers wanted to know each action's costs in detail and the overall costs incurred by the actions or products at the aggregate level.[87]

Ideally, the effective MCS enables making visible and recognizable action patterns by various methods, "that are important to organizational actors with different evaluative principles, a process" (Chenhall *et al.* 2013, p. 269). The actions involved at SunPlants were diverse,[88] and each action consumed various resources (e.g., labor and materials). Through these accounts, MCS functions in order to monitor, evaluate, and improve the actions necessary to achieve organizational goals (Heinicke *et al.* 2016; Simons 1994; Tessier and Otley 2012; Tuomela 2005; Widener 2007). The accounts were set to reflect how each pattern selection was associated with different costs incurred, time consumed, and different outcomes (e.g., product quality).

The old ERP did not integrate the accounts to produce variance information. Thus, it

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[87] That is to say, the action is considered as the control objective, which can be an event, unit of work, or task with a particular goal, such as designing products, setting up machines for production, operating machines, or distributing finished goods, and actions consume overhead resources and are considered as cost objects.

[88] For example, the machining process in which materials are processed consists of drilling, turning, milling, slotting, rolling, planing, skimming, showering, sawing, grinding, sharpening, lapping, welding and other metal workpieces activities, as well as electro-erosion, laser cutting, and other metal treatment actions.

was difficult for SunPlants' managers to select the appropriate patterns in a particular situation characterized by factors, including order quantity, priority, and resource availability. There was a lack of configuration of the fit between the order, actual production capacity, and resource capacity. In turn, SunPlants' managers were not able to make an accurate plan concerning the amount of resource input and the expected output based on the specific pattern. As a result, individual managers usually took "incorrect" actions based on the biased plan, with the lack of uncoordinated actions across different departments already widespread throughout SunPlants.

It was therefore enormously challenging to identify and assign costs to the actions involved and the products produced. Although the old ERP helped to establish a financially centered calculation center, the impaired recognizability induced the failure to trace a specific bundle of material resources that transferred across different spaces and times and among various centers. Consequently, it was difficult to hold most managers accountable or responsible for the correct performance areas.

In summary, the impaired recognizability induced consequentially inefficient problem-solving style at the organizational level, challenging SunPlants to develop RR because the managers' attention was too focused on unnecessary tasks rather than emerging situations.

[Insert Table 8 here]

Table 8 shows how visibility and recognizability relate to the interconnectedness of accounting, technologies, and human actors. Visibility is concerned about how deep the accounting process can penetrate the organizational reality (i.e., the granularity of a control objective, a unit of multiple material resources, or individual material resource). Metaphorically, we need light to make the contents of a dark room visible at night. MCS must retain the visibility of resources through up to date data, information, and knowledge. MCS offering visibility interconnects with digital technologies to collect data and information that monitor (light up) the production process, specifying the evaluation process, and improving the granularity of resources and actions. Visibility is involved in tracing and controlling single action patterns and making decisions based on individual resources and actions.

Recognizability is concerned with how a manager can identify and correct the movement patterns of resources in the production process. Managers use MCS to set the accounts for individual resources and actions and match each to the right categories, integrating the accounts when necessary. MCS offering recognizability interconnects with digital technologies to produce analysis reports based on individual accounts and integrated accounts. Recognizability is involved in setting specific accountability and responsibility and tracing the movement of a specific bundle of material resources across various centers. Recognizability helps managers to consider multiple factors when selecting the appropriate patterns, enabling managers to make ex-ante decision-making and facilitating coordinated actions across different departments.

However, they are fundamental findings, merely offering analytical separation, and do not consider the contextual specifics associated with the entanglement. The next two sections provide an in-depth analysis of specific ERP functions and technologies (i.e., batch management, common parts/materials library, bill of material), MCS practices, and human actions.

4.5.2 Basic and intermediate forms of MCS configurations

Based on Malmi and Brown's (2008) initial study and Bedford's (2020) further research, the basic form and intermediate form of MCS configurations show little interdependence and moderate interdependence of management control practice, respectively (see Table 12). This section identifies that common/shared materials/parts library (CMPL), batch management, and bill of materials (BOM) as essential ERP functions (i.e., technologies) develop the the basic and intermediate forms. This section also explains how the basic and intermediate forms of ERP-based MC configurations develop and evolve in accordance with visibility and recognizability. The basic and intermediate forms progress through capturing resource and action elements, accounting the resources and actions under movement, and digitalizing linkages of resources and actions.

4.5.2.1 Capturing resource and action elements

The basic form of management control configuration is built upon the CMPL. The old ERP did not enable the development of a CMPL. The CMPL consists of information about commonly used components or materials for designing, prototyping, and producing products. Before the adoption of SAP, SunPlants had perceived the importance of such a CMPL to break through the bottleneck in the efficient component or materials selection (CMS) for designing, prototyping, and producing products:

> "With the library, the company is capable of breaking the bottleneck in production and product development." (The R&D manager X)

Several interviewees emphasize that, for SunPlants, CMS was time-consuming and ineffective if there was no superior information-processing capacity. A well-designed CMPL relates to the well-planned options for selecting the materials/components required and available for the (sales) order. In addition, the CMPL is used to guide the design actions as well as the production actions:

> "We are strictly bounded to the delivery date when designing the products… We do the product design for technically preparing the production and ensuring product quality." (The R&D Manager J)

> "SAP with the library significantly facilitates our work efficiency. For example, the inquiry function becomes powerful in the CMS process by using "where used list." (R&D Manager L)

Nowadays, SunPlants has built the CMPL via SAP. Frequent CMS leads to questions concerning which components or materials to select and use for particular production action patterns and whether they have good availability in the supply chain. The CMPL should also answer the questions and offer relevant information quickly so that SunPlants' managers can make decisions and have control over design and production actions. Besides, with SAP-based CMPL, SunPlants tightened the internal actions between production and R&D in order to make decisions based on the options calculated to fit the particular circumstances.

According to existing research, the rapid foundation of CMS involves understanding the similarities of the material resources and the actions involved (D'Adderio 2014; Mazmanian and Beckman 2018; Ribeiro *et al.* 2008; Shanian and Savadogo 2006). This similarity entails enacting the MCS practices to abstract, inscribe, and visualize and recognize all of the material resources and actions involved. Under various circumstances, "a different but similar set of resources is coordinated by a very similar web of relationships" (Winter 1995, pp. 149-150). The effective use of SAP has enabled SunPlants thus:

> "[The] SAP system is rather compelling and is ideal for managing R&D with complex processes, especially for the context where there are more than 1,000 people engaged in production and R&D activities… SAP facilitates the planning function for managing rather complex activities…" (The Deputy Head of the R&D Department)

> "SAP routinizes most activities, which is much more convenient… It is user-friendly and standardizes and solidifies the process and activities, which eliminates unauthorized and frequent modifications in the process and data infrastructure… We can finalize the design much faster than before." (R&D Manager H)

Additionally, SAP-based CMPL has enabled SunPlants to produce long-term procurement plans. Such plans have strategic significance (e.g., Hlioui *et al.* 2017; Hong and Kwon 2012; Lara-Arango *et al.* 2017; Peleg *et al.* 2009; Tomino *et al.* 2012), but were not available during the old ERP period. The use of CMPL helps to describe how a particular material resource relates to different types of actions (e.g., metal workpiece activities and metal treatment activities). Therefore, SAP-based CMPL has made the MCS useful to guide all the material-related actions among the entire lifecycle of a product at SunPlants, from pricing and R&D to after-sales service.

SAP-based CMPL made the MCS practices more relevant to RR. CMPL facilitated SunPlants to develop RR by codifying knowledge about the similarities of resources, formalizing controls, and facilitating decision-making based on extending on to other actions. For example, in addition to long-term procurement, SunPlants' managers used

SAP to effectively make supply chain capacity evaluations (e.g., stock level, procurement plan, purchase delivery time), CMS in R&D, and material substitution in production stages. On the contrary, the old ERP could not support SunPlants in developing the CMPL, failing to allocate and reconfigure material resources appropriately, and inhibiting the extensive use of particular material resources into more comprehensive actions and product ranges.

4.5.2.2 Accounting the resources and actions under movement

The intermediate form of management control configuration is built upon the batch management. This section identifies the use of SAP-based batch management[89] in MCS and its effects on solving overhead control problems. The incorrect overheads in relation to material resources in the production line are an acknowledged control problem (Bryer 2006; Drury 2013; Goddard and Ooi 1998; Malcom 1991; Malmi and Granlund 2009; Pfaff 1994).

When SunPlants' managers was using the old ERP, the financial records of the material resources-related actions did not adequately match the relevant operational characteristics. When the old ERP was used, the overhead collection was problematic because the categorization of material resources was unclear. Some actors could also arbitrarily modify the categorization process. Hence, the addition, deletion, or movement of material resources were not recorded in the valid accounts. For example, some non-auxiliary materials were categorized as auxiliary materials.[90]

Within the old ERP period, MCS focused more on calculating the numbers rather than

[89] A batch is defined as a subset or partial quantity of a material that is managed separately from other subsets of the same material. Each batch is identified not only by its material identification but also by a separate batch number to fit its operation and production characteristics.

[90] For example, both paint and production tools were identified and visualized as the auxiliary materials in the accounting module of ERP. Indeed, production tools were used as auxiliary material in most cases, whereas the paint was not used as the auxiliary material in SunPlants, because it was consumed directly (i.e. surface spraying, instead of equipment maintenance, like stain proofing) as the direct material in the production process. Production tools belonged to non-production auxiliary materials but should not be treated as direct material in the production process.

conforming to the generative mechanisms: the underlying mechanisms inscribed by MCS that generate the numbers (e.g., correct categorization and valid accounts). Several interviewees emphasized that MCS should explain and operationalize the material resource flows throughout the company by breaking the complicated flow into more detailed components involving rational principles, procedures, and steps for reconfiguration needs. The mechanisms involve the means to produce the real values of resources, including data collection, formula, information source, and time issues. In this way, managers could avoid using nominal values to manage material resources.

[Insert Table 9 here]

SAP introduced SunPlants with the function of batch management in order to build generative mechanisms:

> "[The SAP system] can distinguish the purchase [activities] of different raw materials, tracking the final use of the purchased materials, and tracing the finished products after sales. Batch number management is enabled for raw material purchase receipt and storage, production release, finished product storage, sales and delivery, etc.. Subsequently, follow-up material and finished product quality tracking and control are enabled. When finished products are put into storage, all batch numbers and quality certification documents can be analysed and displayed in the unique interface". (PIMM 3.3.1)

Table 9 shows the sub-functions and technical features of the batch management function, and the impact of each sub-function on MCS. From resource specification, classification and batch creation and search, ERP digitalizes the MCS reconfiguration. The digitalization manifests as repairing obsolete action patterns, rebuilding the control logics of the physical resources' movement, mobilizing the formal MCS and enabling effective data infrastructure to the particular MCS form, and maintaining the material resources movement in unstable conditions. Batch management relates to MCS's nature as representing things as they are in real life rather than how they are in the actors' ideas about them. With the new advantages, the internal processes at SunPlants became relatively more transparent and flexible than during the old ERP period.

Further, the improved generative mechanisms formed the basis of effective MCS configurations for the RR. SunPlants' managers could make decision-making and control of material resources more integral to other control mechanisms. For example:

> "After the subsequent batches are managed through the [SAP] system, it will effectively help to enable the follow-up traceability… The [SAP] system supports the batch management for the raw materials… can accurately record the corresponding batch number when entering the warehouse and leaving the warehouse…The system supports batch number management for finished products and key components, facilitating follow-up quality traceability". (PIMM 3.3.2)

There are three aspects. First, managers were enabled to track and monitor the lots during the entire life cycle of the material resources, capturing each lot's unique characteristics (e.g., different expiry dates or dates of production of two lots). Second, SunPlants could evaluate the final use of one material in critical actions. Third, the batch number allowed SunPlants to manage and control some critical business processes.[91]

However, for SunPlants, adopting batch management was not the end of improving overhead controls to continue to develop RR, but the initial step. The batch management merely offered a means (i.e., an elementary form of effective MCS configurations) to continue to relieve the burden of overhead controls. Nevertheless, more methods are expected to be adopted so as to maintain effective MCS configuration and reconfiguration.

At the time of the interview, SunPlants had just attempted to integrate the financial records of the inventory (i.e., materials) with the operational records (i.e., the batch of the materials, the quantity). In this way, a set of MCS practices was expected to reconfigure further. SunPlants requested the vendor to offer a subsequent upgrade on the SAP to develop interfaces between non-financial and financial data of the inventory. This upgrade was expected to enable production managers to view the monetary

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[91] For example, goods received from external vendors or in-plant production, goods issue (from the store to the production department to make the product), finished goods received from the production department, and sale delivery.

amount (i.e., the unit price) of production auxiliary consumed. This reconfiguration would enable the integration of financial control and non-financial controls and support decision-making in reconfiguring some auxiliary materials in some circumstances.[92]

At the conclusion of the interviews, SunPlants was still unable to integrate financial and non-financial records of inventory and then failed to detail the overheads. This does not mean that SAP could not enable this reconfiguration. Most interviewees indicated that too many new ERP functions in this initial stage would complicate the enactment of ERP-based MCS practices and inhibit effective MCS enactment. During this period, actors performed some basic MCS practices relatively easily within the initial three to five years. The effective enactment of the basic and intermediate forms of MC configurations provides opportunities to enhance and complement complicated MCS reconfiguration.[93]

Similarly, existing research also claims that the use of ERP is an ongoing practice and process (e.g., Dechow and Mouritsen 2005; Malmi 2001). As it unfolds, some studies reveal that this process is associated with the ongoing change in the routines, ongoing commitments, and ongoing learning mechanisms, rather than a one-off project (e.g., Akkermans *et al.* 2003; Botta-Genoulaz *et al.* 2005; Chapman 2005; Grabski *et al.* 2011; Jacobs 2007; Kræmmergaard and Rose 2002; Sammon and Adam 2010). Therefore, it is not surprising that SunPlants' managers recently realized their need to integrate the financial records and non-financial records of inventory.

Studying MCS as a package helps to clarify the enormous distinction between "making the overheads visible", "making the overheads recognizable", and "making the overheads controllable". Such a distinction helps in understanding the effect of different MCS configurations due to the particular interconnectedness of technologies,

[92] For example, when the procurement price of a specific material is high, they can reduce the consumption or make substitutions.

[93] The IT infrastructure allowing for continuous MCS reconfigurations is critical. I will illustrate this in the discussion section.

accounting, and users.

The first term (i.e., making the overheads visible) refers to the overheads that can be seen by managers. The second (i.e., making the overheads recognizable) refers to the overheads being recognizable by the managers, and the last (i.e., making the overheads controllable) means that managers can control the overheads. The distinction between these three terms is critical. For example, it is expected that a person can see birds flying, but he/she is not likely to recognize what the flying birds are or where they are flying to; moreover, the person is not likely to be in control of a flying bird.

Undoubtedly, the actors could effectively reconfigure the resources and actions when they use ERP to recognize and control the overheads more effectively. RR not only requires the use of accounting to produce the visibility of resources but also needs ongoing accounting reconfiguration to offer the recognizability[94] of resources and actions. Visibility must be the prerequisite to recognizability. For effective MCS configuration, visibility and recognizability must work together.

4.5.2.3 Digitalizing linkages of resources and actions

Making the (multiple) resources flow tracible is insufficient to solve the overhead control problems, but how resource flow can run with well-structured data and information is critical to improving overhead control practice. Well-structured data and information are based on a properly designed organizational structure (e.g., Lin 2011; Qiu and Lin 2011; Raymond *et al.* 1995). At SunPlants, the old ERP became a burden to the organizational structure. The old ERP made the actors to be distracted when they were taking actions. Social problems rather than technical issues have been recognized to be (e.g., Dechow and Mouritsen 2005; Quattrone and Hopper 2005) induced to

[94] According to Merchant and Van der Stede (2007), controllability means for effective MCS, the employees whose behaviors are being controlled must be able to affect the results in a material way in a given time period. The main rationale behind the controllability principle is that MCS is useful only to the extent that they provide information about the desirability of the actions that were taken. If the actions are totally uncontrollable, the MCS reveals nothing about what actions were taken. Partial controllability makes it difficult to infer from the MCS whether or not good actions were taken.

influence controls' logic. The old ERP brought about a messy data source, plus redundant and unnecessary actions. As a result, these deficiencies usually led to inefficiency in single MCS practices (e.g., pricing skills, CMS, and overhead controls), and the managers could then not make timely decisions for each sale order. Most employees considered the old ERP as a way to "gild the lily":

> "Without the [old] ERP systems, our on-time delivery rate was about 80%, but ERP caused it to drop to nearly 60%... The company spent 15 million Yuan on buying new information systems, but the effect was minimal… [He joked, saying:] The ROI might be higher by using the money to [financially] motivate the employees…" (the Deputy Head of the R&D Department)

Similarly, some interviews highlighted that not only did the old ERP fail to support individual MCS practices, but also it was unable to facilitate the MCS reconfiguration to address the operational complexities. In addition, the old ERP constructed an information infrastructure that did not match or appropriately integrate with the existing organizational structure and processes used at SunPlants. Subsequently, the structure of the power of discretion was not configured by an effective set of MCS practices. Hence, the old ERP failed to enable MCS configuration to penetrate deeper into organizational reality.

SAP helped to solve these problems. At SunPlants, SAP has enabled MCS reconfiguration, which continuously produced visibility and recognizability by building proper (digital) linkages and structures between critical actions to maintain and improve existing structures. For example, SAP helped SunPlants to build critical linkages and structures in supplier management actions and quality control actions. SAP also helped SunPlants to divide and code the status of and actions related to the goods purchased. The action of a quality check for purchased goods was necessary for supplier management and quality control, which occurred before the material was formally stored in the SunPlants' warehouse.

Two actions were divided and coded to support enacting inspection of the incoming goods. The first was coded as "103" to represent "not inspected", and the second was "105" to represent "inspected". These two statuses guided different actions. Adding the

"103" stage allowed incoming goods to be put in the warehouse that were not accepted. Afterward, at the "105" stage, the ownership was transferred if the inspection went through.

Additionally, SAP promoted tight control by imposing SunPlants' staff to carry out these two actions strictly in sequence; otherwise, the process would not transfer to the next:

> "The aim of using ERP [SAP] is simplifying the complicated things (e.g., data and processes), then we are allowed to standardize and normalize the processes, and we have the opportunity to digitalize and process them." (Marketing Manager K)

This measure produced critical procurement action information (e.g., procurement quality information). The coded actions and information produced continuously enabled SunPlants to build the linkage and structure of procurement actions. In this way, SunPlants developed tight controls over procurement actions.[95]

Before SAP, the linkage and structure were broken. With the old ERP, SunPlants did not execute incoming goods inspections where purchased goods were checked and accepted by SunPlants. Thus, SunPlants could not impose tight control over supplier management actions and quality control actions. There was a shortage of critical procurement action information (e.g., procurement quality information) and a loophole in the action patterns. Most incoming goods were not put in the warehouse for careful inspection.

In other words, the improved information infrastructure of identifying, coding, and visualizing new actions mobilized tight controls over critical processes. Also, tight controls enabled SunPlants to develop visibility and recognizability from multiple centers. In turn, new actions produced additional information to retain multiple information supply and sources (e.g., information about the inspection), strengthening the feedback loop between MCS practices and systems relevant to everyday operational actions. Therefore, RR was enhanced by developing effective MCS reconfiguration to

[95] Tight control means that the incoming goods inspection action has to comply.

continuously produce visibility and recognizability across SunPlants.

4.5.3 The advanced form of MCS configuration

This section reveals how the post-upgrading of ERP enables the advanced form of MC practice to be reconfigured with extensive interdependence and how MCS is involved in digitalizing and capturing resource and action changes, mobilizing cross-functional or departmental actions, maintaining production efficiencies, and long-term benefits.

4.5.3.1 Digitalizing and capturing resource and action changes

At SunPlants, the bill of materials (BOM) is critical product technical data. A BOM is also known as the formula, recipe, or ingredients list, which offers the basis for facilitating the efficiency of individual actions and optimizing the action patterns (see Diagram 9).

[Insert Diagram 9 here]

At SunPlants, BOM had a central role in stabilizing production actions. When SunPlants received an order from a customer, the BOM unfolded to produce information that estimated the total amount of materials needed to accomplish it. The information specified the amount of materials that the workers were allowed to pick up to meet both expected efficiency and effectiveness.[96] BOM plays a dual role in MCS in terms of planning and centralizing decision-making in resource allocation:

> "Although BOM cannot correctly represent the management control of the production line in the company, it can reflect the standardization level of the company, and a good BOM can enhance the material commonality… In this way, the diversification of material procurement is developed… So, it can be said, BOM also represents the cost performance of product design, especially the material substitutability, including substitution among different types of materials, among different brands, among different sizes…Also, BOM represents the company's ability to resolve the conflict between the engineering department and production department because the CMS or substitution is a compromise process in nature…If BOM takes the situation where substations are required into

[96] In other words, the workers in the production line do not need to attend too much attention to determine which materials (are allowed) to select and pick up.

account, conflicts can be avoided or resolved faster…" (Production manager W)

BOMs were the essence of management control over material movement at SunPlants in two ways. First, a BOM presents product hierarchical structures, depicting the constituents of the materials (e.g., Huang *et al.* 1999; Jiao *et al.* 2005; Männistö *et al.* 2001; Xu *et al.* 2007). A BOM is constructed through a list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts, and the quantities of each SunPlants' production line requested for the production actions. SunPlants' managers used BOM to specify the elements, hierarchies, and structures of products, and then BOM provided and became a way to improve MCS's item-level visibility. By helping managers ensure the appropriate parts and materials are available at the right time and in the right quantities, BOMs support managers in remaining within budget and on schedule.

Second, BOMs embody the action patterns involved in the production. When production orders are created, BOM often links to a production order. BOM supports actors creating the production order to generate reservations for components or materials that are in stock or requisitions for purchasing components that are not in stock (e.g., Bruccoleri *et al.* 2014; D'Avino *et al.* 2014; Lee and Adam Jr 1986; Mantel *et al.* 2006; Wu and Hsu 2008; Xiong *et al.* 2003). By linking production, inventory, and purchasing actions, BOM offers and becomes a way to improve the recognizability necessary for MCS.

At SunPlants, BOM that acted on MCS in terms of visibility and recognizability promoted the reconfiguration of material resources following the actual production and inventory conditions. For example, when one material resource faced a temporary shortage, the originally designed pattern and sequence by which the materials should be processed and assembled has had to change:

"When the production line finds out that they can use an 8 cm raw material, instead of a 6 cm that was previously used, the sequence of the production routings or even the processing technology are changed." (Production Manager W)

Hence, BOM helped SunPlants' managers to visualize the elements, hierarchies, and structures of products, recognizing the action pattern for production, and identifying how to change the action pattern when other changes emerge.

4.5.3.2 Mobilizing cross-functional or departmental actions

At SunPlants, there were two types of R&D prototype drawings: temporary drawings and formal drawings. Some temporary drawings were to be converted into formal drawings after successful experiments and trials. However, both formal and informal drawings were stored in specialist software (e.g., Solidworks and CADworks) rather than in the old ERP. This made the management control over R&D actions problematic:

> "Manually creating a directory for file management is time-consuming and laborious, which [is] prone to errors; (PIPL 2.6.1)
>
> It is not convenient for the production staff to collect the drawings; (PIPL 2.5.1)
>
> The time for collecting drawings cannot be recorded, and it is inconvenient to traceback; (PIPL 2.6.1)
>
> Drawings cannot be directly converted to BOM through the system, resulting in human errors; (PIPL 2.2.1)
>
> Drawing access permission cannot be distinguished, resulting in confidentiality issues; (PIPL 2.6.1)
>
> All R&D project progress is manually compiled; (PIPL 2.1.8)
>
> [There are] incorrect cost collection methods." (PIPL 2.4.1)

The old SunPlants' ERP did not support the storage, modification, and maintenance of the product design information (i.e., the drawings and BOM). Thus, several deficiencies arose.

The design information lacked consistency and quality assurance in querying, adding, editing, and deleting information items. Besides, the lack of accuracy and accessibility of product design information induced engineers and designers to take the time to request and trace the drawings and product design information. Subsequently, the engineers and designers adopted their preferred means to codify the drawings, even in papers. Such deficient information inhibited the use of single MCS practices (e.g., planning).

These deficiencies induced MCS inefficiency, inhibiting the effective on-going MCS configurations. Although some policies and principles were inscribed in the MCS to guide the actions, decision-making and control in production actions and procurement actions were ineffective. For example, SunPlants faced difficulties in quickly ensuring the customer order decoupling point and order consolidation representing the forecasting or (action) planning effectiveness:

> "[Through the use of the old ERP], the execution of BOMs is a compromise process in nature…Especially between the R&D department and the production department… Improper BOMs lead to conflicts between them… It incurs huge maintenance costs… Some temporary substitutes or short-term substitutes were used as a long-term substitute in the production line, which disturbs the R&D department… The update of the BOMs is a huge project… For example, a supplier has stopped the supply of some old products (raw materials), and new products (raw materials) are being supplied "temporarily" or "shortly" … The new ones have replaced the old ones because the old ones are no longer in use… The update of the BOMs is not merely the responsibility of the R&D and production departments…The BOMs were not updated until the adoption of SAP…" (Production manager W)

At SunPlants, SAP solved these deficiencies by offering the R&D staff a means by which to load their design drawings via the CAD interface and make extensive use of them. SAP helped to manage components, assemblies, and drawings, and other relevant documents in a standardized form. SAP also offered a way to codify and store the drawings within the drawing conversion process. This enabled SunPlants to have consistent information flows and processes to solidify the structure of the actions.

Since data and information were being codified, stored, and connected in a centralized system to reduce redundant and unnecessary information-processing operations and a smoother information flow, SAP enabled actors to track the design progress and apply appropriate changes as permitted. Actors could also link drawings to integrate other resources through information, including materials, equipment, or functional locations.

4.5.3.3 Maintaining production efficiencies and long-term benefits

SAP provided BOM flexibility in the production line to cope with an emergency. The

BOM describes a product's structure[97] by nodes and layers, typically including the finished product layer, part layer, subcomponent layer, assembly layer, and raw material layer (see Diagram 9). SunPlants frequently designed for orders with new product needs in different situations (i.e., boxes with full stops represent materials and components (re)configured according to particular products ordered). Thus, BOM's structure must be flexible and reconfigurable enough to match customer needs, production routings, and the current production capacity. Indeed, SAP supported SunPlants to make BOM's structure flexible and reconfigurable.

However, BOM's flexibility that was promoted by SAP may induce an inappropriate use of BOM and harm the long-term advantages. An example is emergent outsourcing. Emergent outsourcing is required to reach RR (e.g., Johnson 2006; McCarthy and Anagnostou 2004; Sommer 2003). At SunPlants, this outsourcing took place to compensate for the temporary inadequate production capacity. Effective emergent outsourcing could also prevent SunPlants from delaying an order delivery. To make the emergent outsourcing beneficial to the production line, BOM must remain flexible and reconfigurable. Based on the existing BOM's structure, SunPlants' planning and R&D staff created a new BOM node or layer to manage the emergent outsourcing order(s) and actions, and would then remove the added node when the outsourcing order was finished:

> "Outsourcing usually took place because we assume the production capability as "infinite capacity", so that sale order would not be rejected when production capability and material stock are not "sufficient" at the time an order comes… Outsourcing usually took place in a situation where the production line realized that they could not finish the production order when the production order had been processed because the BOM was not accurate enough to show us the actual inventory and stock…" (Production Manager W)

However, for SunPlants, such flexibility merely contributed to production efficiency at the production line level, but not to the long-term benefits, and it even complicated

[97] At the time of the interview, SunPlants were always structuring the BOM in four or five layers in both old ERP and SAP, which matches the inner structure of a product.

MCS enactment.

This kind of outsourcing prevented SunPlants from developing long-term advantages. Indeed, the emergent outsourcing orders occurred and brought about flexibility in the production actions through fast planning renewal. The problem arose in terms of how to maintain effective enactment of MCS for the outsourcing orders.

Adding new nodes and increasing the number of layers to the existing BOM helped SunPlants to manage the emergent outsourcing orders. On the other hand, to maintain the effective MCS enactment for these orders, SunPlants must have more data and information to fulfil the added nodes. The information was needed to connect other relevant actions and resources (e.g., inventory, quality control, delivery, payment, and return actions); otherwise, the emergent outsourcing order would lose control over time.

In other words, the flexibility in the production actions level to promote RR is based on sufficient information supply. Sufficient information supply fundamentally maintains a completely effective feedback loop for enacting MCS dealing with emergent outsourcing. Also, the communication mechanism embedded within the MCS should be well-designed and configured in ERP so that effective MCS enacts to support the ongoing RR.

However, as the emergent outsourcing order complicated the production actions and induced further control problems, SunPlants attempted to reduce RR's dependence on production outsourcing. The interviewees indicated that emergent outsourcing was primarily attributed to the non-transparency and inflexibility of the production and R&D processes. The ongoing use of emergent outsourcing merely tolerated or even spoilt the non-transparency and inflexibility. The interviewees indicated that the practices of the emergent outsourcing seemed to result from the inaccuracy of the capacity evaluation, and thus improving the accuracy became the key to solving this issue:

> "It is quite normal to see that some employees who are not able to absorb new skills and new tools easily are the most likely to reject the use of information systems. For example, they would see the

very convenient payment technology (i.e., Wechat, Alipay) that most Chinese young people consider as a necessity in daily life as unnecessary in their life…They are most likely to blame the errors in the information on the information systems…" (Software Engineer S)

Furthermore, the inaccuracy of the capacity evaluation could not be entirely attributed to the old ERP. Metaphorically, a blunt knife is blunt, not because it is blunt per se, but because the knife owner may not sharpen it regularly. The reliable capacity evaluation depends on transparency and flexibility of the internal process and the generative mechanisms to produce accounting numbers and management information.

Table 10 shows how the post-upgrading of ERP benefits MCS practices in concrete terms, respectively. Through the case of SunPlants, this chapter contributes to the accounting literature by extending knowledge on how the post-upgrading of ERP and MCS changes continue to work effectively within a company. However, the findings merely reveal how the post-upgrading of ERP improves the decision-making and control actions of each MCS practice, thus next section discusses how individual MCS works together.

[Insert Table 10 here]

4.6 Discussion

By investigating the action planning, working procedure, organizational structure, and hybrid measurement systems that were based on ERP (for example of these practices observed, see Table 11),

[Insert Table 11 here]

The case findings reveal the forms that ERP-based MCS configures and reconfigures and how they develop RR. This section consists of two main subsections to discuss how the post-upgrading of ERP benefits different MCS configuration forms and affects RR. The first subsection discusses and compares how the three distinctive ERP-based MCS configuration forms are involved in different levels of complexity of actions and resources to produce various levels of visibility, recognizability, and controllability. The second subsection discusses how ERP-based MCS configurations help materialize RR by focusing on how the structural rigidity and functional flexibility of ERP contribute to MCS configuration.

4.6.1 Implications for MCS configuration via the post-upgrading of ERP

According to the findings, Table 12 summarizes three forms of MCS configurations and how they develop and evolve in terms of visibility, recognizability, and controllability within the context of RR. Accordingly, the findings shed light on three implications.

[Insert Table 12 here]

First, these three varying forms of MCS configurations imply the importance of recognizability in ERP-based MCS configurations. When studying broader MCS mechanisms, shifting the focus of visibility to recognizability may be critical. Data and information should demonstrate and make the resources and actions visible before developing the recognizability. Earlier research indicates that the implementation of ERP is much more than merely transferring data from the legacy systems into the new ERP system (e.g., Scapens and Jazayeri 2003). However, existing research exclusively focuses on improved visibility and control by using ERP (e.g., Dechow and Mouritsen 2005; Quattrone and Hopper 2005), such as the performance visibility presented by accounting numbers (Quattrone and Hopper 2001, 2005). The post-upgrading of ERP is intended to enable analytics related to the recognizability of organizational resources and actions.

Recognizability is significantly constructed based on diffused visibility, but visible resources may not be recognizable or accountable.[98] For example, the old ERP enabled the visibility of the resources and actions through nominal values and numbers, but the visibility based on nominal values and numbers had limited significance to develop the recognizability necessary for decision-making and control. The shift from visibility to recognizability enhances the understanding of how ERP enables MCS to be configured and reconfigured to offer valid decision options, identify the tacit relationship between organizational resources or actions, enable cross-functional integration, and strengthen the feedback loop across broader control mechanisms. Based on the recognizability, this chapter offers insight into examining ERP's effect on enacting MCS and exploring new ways to improve ERP's performance effect on MCS.

Second, studying how the post-upgrading of ERP develops recognizability is critical to understand how to make ERP dominant in multiple MCS practices to cope with external changes. The lack of recognizability induces problems in coping with emergent changes through ERP-based MCS within dynamic and unstable conditions. Recognizability reinforces the need to understand "how multiple spaces and times act concurrently on work activities" (Quattrone and Hopper 2005, p. 760). Robson and Bottausci (2018, p. 71) demonstrate that:

> "Changing information flows and dispersed access to data entries resulted in the emergence of multiple and shifting center(s) and peripheries, with different interests and demands, installing a form of mutual control and diffused visibilities that made action at a distance impossible".

Table 12 shows that visibility by managers merely sustains effective control over resources and actions when they are relatively static within a single space and time or moved in simple patterns. At the same time, recognizability saves managers' time and speeds up their decision-making process in unstable conditions. Recognizability helps managers to understand more about the actions to be controlled and the action's results

[98] For example, in the production line, lots of materials and machines are visible, but perhaps we would not recognize them, because we would be somewhat unfamiliar with them (e.g., name, property, the ways or pattern to process them, and people who are accountable for them) and would not know who are accountable for them.

that are interdependent of other actions. In addition, viable alternatives find expression at various levels, including the level of single resources and actions, the level of resources and actions group, and the level of change in resources and actions group. An ERP upgrade is suggested to expand the range of acceptable alternatives, and thus managers could communicate more effectively with others and are more capable of affecting the action results. Furthermore, in turn, ERP could be dominant in multiple MCS practices.

Third, ERP enables the coexistence of multiple forms of MCS configurations within a company. The co-existence fits different action patterns and eliminates conflicts arisen from a single MCS configuration. The multiple forms of MCS configurations reveal the complexities of the reconfiguration process at multiple levels (Dechow and Mouritsen 2005; Quattrone and Hopper 2005; Scott and Orlikowski 2014; Wagner *et al.* 2011). Different forms of MCS configurations fit the visibility, recognizability, and controllability of different resources and actions to be controlled. For example (see Table 12), in the basic MCS configuration, the visibility of resources and actions merely relates to understanding the similarities of the resources and the actions involved. By contrast, in the advanced MCS configuration, the visibility is concerned about how to support product hierarchical structures or product breakdowns and the way to produce additional information supply and sources from newly added actions.

Also, according to Merchant and Van der Stede (2007),[99] different forms of MCS configurations specify different performance areas in which actors are held accountable for their concrete actions and keep enacting MCS that is good enough at a reasonable cost level. For example, ERP enables the basic configuration form to hold actors accountable for the actions across a product's entire life cycle. In contrast, the advanced form involves performance areas in reaching ambidexterity of both production efficiency and long-term benefits. Also, the basic one lies within the single resources

[99] Merchant and Van der Stede (2007, p. 537) state the controllability as: "Hold employees accountable for the performance areas you want them to pay attention to."

and actions, while the advanced one lies within the level of change in resources and actions group to cover a more dynamic scope of the MCS practices.

According to these three implications, the impact of the post-upgrading of ERP on configuring MCS is apparent in improved visibility, recognizability, and controllability. The post-upgrading of ERP shifts from data collection and integration relevant to visibility to improving recognizability relevant to analytics in decision-making. The post-upgrading of ERP also enables the coexistence of various forms of MCS configurations to afford different kinds of visibility, recognizability, and controllability to fit various dynamic levels of actions and patterns.

4.6.2 *Implications for reconfiguring MCS to cope with environmental dynamics*

These findings help to recognize that RR's materiality could be achieved by using particular ERP technologies (e.g., CMPL, batch management, and BOM) and MCS practices. The understanding manifests itself in three ways: first, how ERP promotes MCS practices coping with increasingly dynamic actions and processes; second, how ERP enables MCS practices to avoid radical changes in existing resource bases; and third, and how ERP supports reconfiguring MCS for RR.

First, understanding the structural rigidity helps to explain how MCS handles increasingly dynamic actions and processes associated with RR. Representing the inherent inseparability of social and material aspects of organizational actions (Orlikowski and Scott 2008), ERP's structural rigidity helps achieve tighter accountabilities in hierarchies and orders so as to maintain the diffused visibilities and recognizability. This addresses the debate concerning how ERP stabilizes accounting processes and structures (e.g., Granlund and Malmi 2002; Scapens and Jazayeri 2003; Wagner *et al.* 2011) or induces constant accounting changes (Dechow and Mouritsen 2005). In particular, the structural rigidity functions to keep the consistent form of mutual MCS practices. This helps explain how to use ERP to handle adverse MCS changes (e.g., some actors could arbitrarily modify the material resource categorization) induced by increasingly dynamic actions and processes.

Second, ERP has to be flexible in functionality in order to make incremental accounting changes conducive to changing the resource base to reach RR. Although existing studies claim that accounting practices are difficult to change after the initial ERP configuration (e.g., Dechow and Mouritsen 2005), I reveal that the enabled functional flexibility of ERP could support MCS configuration to make minor adjustments. The minor adjustments help to maintain or alter action patterns based on the existing base. Although the ERP upgrade per se is radical, it might not induce radical modifications in MCS and radical resource base changes.[100] The upgrade built an infrastructure that allows for incremental MCS changes and ongoing MCS reconfigurations through minor and flexible IT changes. For example, the main MCS changes lie within clarifying and visualizing the processes, hierarchies, and structures, rather than radically changing them, and did not lead to radical changes in the existing resource base. Also, at least at SunPlants, this form of change supports the managers to make decisions and exert control in order to keep the company operating effectively in a dynamic environment.

Third, the fit between structural rigidity and functional flexibility is critical in developing MCS configurations to support RR. The lack of the fit would not support any of the three forms of configurations at SunPlants to build the RR involving thousands of types of material resources and actions. The structural rigidity establishes the institutional foundation of RR. Then ERP can be flexible in the functionality and adapt to changing conditions and requirements so as to improve the RR over time, such as the flexible use of ITs to visualize more resources and actions and to recognize their interconnected relationships. The old ERP did not create the right fit between structural rigidity and functional flexibility, and thus the MCS was closed to possible change.

At SunPlants, this fit enabled MCS to be reconfigurable in order to allow more control and decision alternatives in coping with emerging changes and support situated actions. Dechow and Mouritsen (2005) demonstrate that, "…there are also supplements in the

[100] For example, the business process re-engineering (BPR) that represents a radical change (Stoddard and Jarvenpaa 1995) did not occur due to the ERP upgrade.

form of additional technologies, hand-carried data sets, attempts to circumvent the agency expressed by ERP" (p. 699), and actors are forced "to create supplements that can help to make ERP performative by building representations that 'do the work'" (p. 723). MCS effectively directs the actions and performance areas within the existing resource base when the fit is present. This would make actors efficient in performing the established action patterns and less inclined to develop private patterns that would distort RR.

According to these three ways, the resulting impacts enable RR to function, when the ERP infrastructure involves the fit between structural rigidity and functional flexibility of ERP. The structural rigidity stabilizes the enactment of MCS configurations and prevents arbitrary modifications by individuals. The functional flexibility supports MCS reconfiguration (e.g., from the basic to the advanced form), to continuously improve the visibility, recognizability, and controllability to fit RR that is not unified in a unique form. Whether or not this fit is present in the company is critical. For example, at SunPlants, much additional information was obtained in order to keep multiple information supplies and sources in supporting rapid planning modifications to cope with change. In contrast, human actors must keep using consistent means to process information.

In summary, these six issues may be helpful in extending the existing MCS-ERP literature. Although the existing literature has highlighted the importance of ERP in MCS practices, the literature constructs the knowledge base through a focus on the whole MCS to reveal the floating and heterogeneous nature of ERP-based MCS practices (Dechow and Mouritsen 2005; Granlund and Malmi 2002; Hyvönen *et al.* 2008; Quattrone and Hopper 2005), and on specific MCS to reveal the local interconnectedness of technologies, human actors and accounting involved in ERP-based MCS practices (Wagner *et al.* 2011). Through concentrating on how multiple MCS techniques configure and work simultaneously to reach effective control outcomes (Bedford and Malmi, 2015; Kennedy and Widener, 2008; Malmi and Brown, 2008; Sandelin, 2008), such six issues fall between the whole MCS and specific MCS. They strengthen the knowledge base by capturing how local ERP-based MCS practices vary as floating and heterogeneous configuration forms over time.

4.6.3 Implications for the constitution of an effective MC package

Additionally, discussing the implications for both MC configuration and resource reconfiguration provides a chance to address one of the critical challenges in studying MCS as a package that Malmi and Brown (2008) recognize in their study. The challenge is 'what conceptually constitutes an MCS package; what is included, what is left out, and why?' (Malmi and Brown 2008, p. 288). Thus, this chapter provides insight into the constitution of an effective MC package.

The result of this chapter implies that no one unique MC package exists within a company. Consistent with existing research (e.g., Bedford 2020), this chapter confirms that multiple MC packages with differing interdependencies of MC practices work together within a company. Moreover, this chapter reveals that one MC package might be constituted by two or three interdependent MC practices or techniques. It is merely used to solve simple control problems due to allocating single resources and performing single activities. For instance, it could help managers solve the shortage of information supporting managers in allocating resources for single orders. One MC package might be constituted by three or more MC practices or techniques because it solves more complicated problems due to changes of any group of resources and activities. For instance, it could help managers solve the shortage of information supporting managers in allocating resources for simultaneously dealing with changes in multiple sale orders. Also, one MC technique might be used in different ways when it is used in different packages. They differ in the function of decision-making and the function of control (Malmi and Brown 2008), different control problems, and different means of improving it in particular contexts. For example, in the basic form, SAP improved the data structure of material resources for supporting planning-based decision making in the operational line; in the intermediate form, SAP improved the integration of different sources of data for more effective planning-based overhead control in the operational line.

However, some particular MC practices must be left out in particular MC packages subject to specific control problems. Bedford (2020) specifies two types of MC practice(s) that should be better left out for building an effective MC package, one being the exacerbating MC practice(s) and one being the instigating MC practices(s). The exacerbating MC practice(s) refers to the MC practice(s) that "accentuates the detrimental effects of another MC practice to worsen a control problem" (Bedford 2020, p. 3). The instigating MC practices(s) refers to the MC practice that "creates the conditions that trigger another MC practice to worsen a control problem" (Bedford 2020, p. 3).

Indeed, Bedford (2020, p. 3) describes an ideal MC form constituted by interdependent MC practices to deal with particular control problems without incorporating instigating and exacerbating MC practices. However, in fact, managers may be ambivalent about using some MC techniques. I would prefer to say that one MC technique might be spotty or patchy—it could be good, successful or effective sometimes or in some situations, but not in other occasions. There would be no absolutely instigating and exacerbating MC techniques. In practice, managers perhaps could only minimize the instigating and exacerbating impacts of some MC practices that are inevitably incorporated in a particular MC package. This is because managers usually face a compromise situation. A manager's job is not merely to solve one or two control problems but lots of control problems from a holistic perspective.

For example, at SunPlants, BOM-based management of the emergent outsourcing orders supported fast planning renewal, which helped the production line maintain operational goals. Production staff thought this could be an effective way to support their day-to-day work, but senior managers clearly understood this would cause long-term damage. Of course, senior managers did not abandon the use of emergent outsourcing orders and related fast planning renewal. Although they knew the source of the problem, they could not do that emotionally and technologically until they initiated their resource reconfiguration strategy and new data technologies that improve the internal process.

In other words, the fit between each MC practice incorporated in a particular MC package seems to be ideal or realistically difficult. Demartini and Otley (2020) demonstrate that MC techniques of a MC package would being neither totally uncoordinated nor perfectly integrated. Of course, there would be no one right way to say what a fit is good or not. But does the impossible fit discourage us from pursuing a more effective MC package? The answer should be no. Miller (1986, p. 263) says “piecemeal changes will often destroy the complementarities among many elements of configuration”. On the other hands, wise managers would embrace the change to improve the complementarities because when changes take place, “limitations of the information provided by one management control can be complemented by information from the other management control, allowing the understanding of different aspects of …. actions should be taken” (Academy of management reviewHenri and Wouters 2020, p. 4). Thus, what is more important than the ideal fit is managers’ consciousness of adjusting or changing particular MC packages through, modifying, adding, or abandoning MC technique(s), in order to overcome the up-to-date problem(s) that derived and embrace the strategic shift.

4.7 Conclusion

This chapter reveals that the ERP-based MCS changes that promote material resources-related actions lie within three configuration forms: the basic, intermediate, and advanced forms. The three forms describe how MCS techniques are configured and reconfigured to cope with different levels of complexities of resources and actions. Each form also produces varying levels of visibility, recognizability, and controllability of material resources and related actions, leading to different methods of resource reconfiguration.

Additionally, based on the three forms, this chapter recognizes the importance of the dynamic fit between structural rigidity and functional flexibility of ERP in maintaining effective MCS reconfiguration and control outcomes for reconfiguring resources. In this way, MCS can maintain and alter organizational action patterns to stabilize the company while preventing radical modification of existing principles in dynamic conditions.

This chapter makes three contributions. First, it empirically contributes to the MCS-ERP literature by providing initial evidence on the impact of structural rigidity and functional flexibility of ERP on enabling various MCS configuration forms. Such new evidence also implies that MCS and ERP that work together in dynamic conditions may be sensitive to the fit between structural rigidity and the functional flexibility of ERP. This evidence is important in order to update the MCS-ERP literature, because existing studies that are primarily based on relatively stable conditions do not reckon with the emergent IT infrastructure and MCS changes that serve to stabilize a company's operation in dynamic conditions. The evidence could also suggest that future MCS-ERP studies embrace the multiple aspects (e.g., structural vs functional) of ERP and how each aspect affects MCS integration.

Second, this chapter contributes to Malmi and Brown's (2008) theoretical framework by clarifying how individual MCS techniques are configured and reconfigured. This incremental contribution is important because it theoretically contributes to the limited but essential understandings of how multiple MCS techniques are actually configured and reconfigured in a company (e.g., Bedford *et al.* 2016; Malmi and Brown 2008; Otley 2016; Sandelin 2008). Not only does it confirm the existence of the combinative form of MCS techniques in the case company, but also it indicates that ERP might be critical in realizing the combinative form of MCS practices. Additionally, ERP-adopting companies might rely on the coexistence of multiple MCS configurations. This understanding could suggest that the future studies that are based on Malmi and Brown's (2008) framework consider, first, the multiple instead of the single MCS configurations and second, technology-in-use that might make the MCS configurations differ.

Third, identifying three MCS configuration forms offers practical insights into accounting digitalization as an area that challenges the current accounting practice (Bhimani and Willcocks 2014; Quattrone 2016). The three forms of MCS configurations allow us to capture how the MCS configuration is constructed in terms of visibility, recognizability, and controllability, and how the configuration varies across various levels of action dynamics and complexities. Such three forms broaden the scope of MCS practices by producing visibility by numbers and reporting, to offering decision alternatives using analytics via digitalized means.

Although I have identified some contributions in this chapter, this chapter is bound to some limitations. In this chapter, I do not observe the impact of ERP on rewards and incentive systems and cultural control[101] due to accessibility and ethical problems. Although Girod and Whittington (2017, p. 1123) claim that "reconfigurations do not entail widespread changes in reward or career structures," I suggest that not focusing on rewards and compensation and cultural controls would cause biases in the research outcomes. Future research is encouraged to develop methods to avoid ethical problems to study the rewarding and compensation, and cultural controls. Second, this chapter does not clarify how a set of MCS techniques or practices is selected to configure in ERP. This chapter's focus is the configuration and reconfiguration per se and their impacts on business strategy. Future research is encouraged to advance knowledge by focusing instead on selection issues.

Additionally, I encourage future research to enter into a broader context beyond actions related to material resources. Specifying a situation to see how ERP can (or cannot) work with MCS to produce visibility and controllability makes more specific impacts on organizational actions that require further investigation (e.g., operational level vs

[101] I was not allowed to access the data in relation to rewards and compensation systems.

strategic level, intradepartmental level vs inter-department level, or single-action vs bundled actions).

Table 7 Management control systems package, Sourced from Malmi and Brown (2008, p. 292)

Elements	Description	Components
Planning	Ex-ante form of control (Flamholtz et al., 1985); first it sets out the goals of the functional areas of the organisation thereby directing effort and behaviour; second, it provides the standards to be achieved in relation to the goal, making clear the level of effort and behaviour expected; third, it enables congruence by aligning goals across the functional areas of an organisation, thereby controlling the activities of groups and individuals.	Action planning—goals and actions for the immediate future, usually a 12-month period, are established; has a tactical focus. Long-range planning—the goals and actions for the medium and long run are established; has a more strategic focus
Cybernetic	There are five characteristics of cybernetic control (Green and Welsh, 1988). First, there are measures that enable quantification of an underlying phenomenon, activity or system. Second, there are standards of performance or targets to be met. Third, there is a feedback process that enables comparison of the outcome of the activities with the standard. This variance analysis arising from the feedback is the fourth aspect of cybernetic control systems. Fifth is the ability to modify the system's behaviour or underlying activities.	*Budgets* (Bunce et al., 1995; Hansen et al., 2003), *Financial measures* (Ittner and Larcker, 1998), *Non-financial measures* (Ittner and Larcker, 1998), *Hybrids* that contain both financial and non-financial measures such as the Balanced Scorecard (BSC) (Greenwood, 1981; Kondrasuk, 1981; Ittner and Larcker, 1998; Kaplan and Norton, 1992, 1996a,b, 2001a,b; Malina and Selto, 2001)
Reward/compensation	Motivating and increasing the performance of individuals and groups through attaching rewards to control effort direction, effort duration, and effort intensity.	Attaching rewards and or compensation to achievement of goals (Flamholtz et al., 1985; Bonner and Sprinkle, 2002)
Administrative	Administrative control systems are those that direct employee behaviour through the organizing of individuals (organisation design and structure), the monitoring of behaviour and who employees are made accountable to for their behaviour (governance); and through the process of specifying how tasks or behaviours are to be performed or not performed (policies and procedures), (Simons, 1987).	*Organisational design and structure* (Otley and Berry, 1980; Emmanuel et al., 1990; Abernethy and Chua, 1996; Alvesson and Karreman, 2004), *Governance structures* within the firm (Abernethy and Chua, 1996), *Procedures and policies* (Macintosh and Daft, 1987; Simons, 1987)
Culture	The values, beliefs and social norms which are established influence employees behaviour. (Birnberg and Snodgrass, 1988; Dent, 1991; Pratt and Beaulieu, 1992).	*Value-based controls* (Simons, 1995), *Clan controls* (Ouchi, 1979), *Symbols* (Schein, 1997)

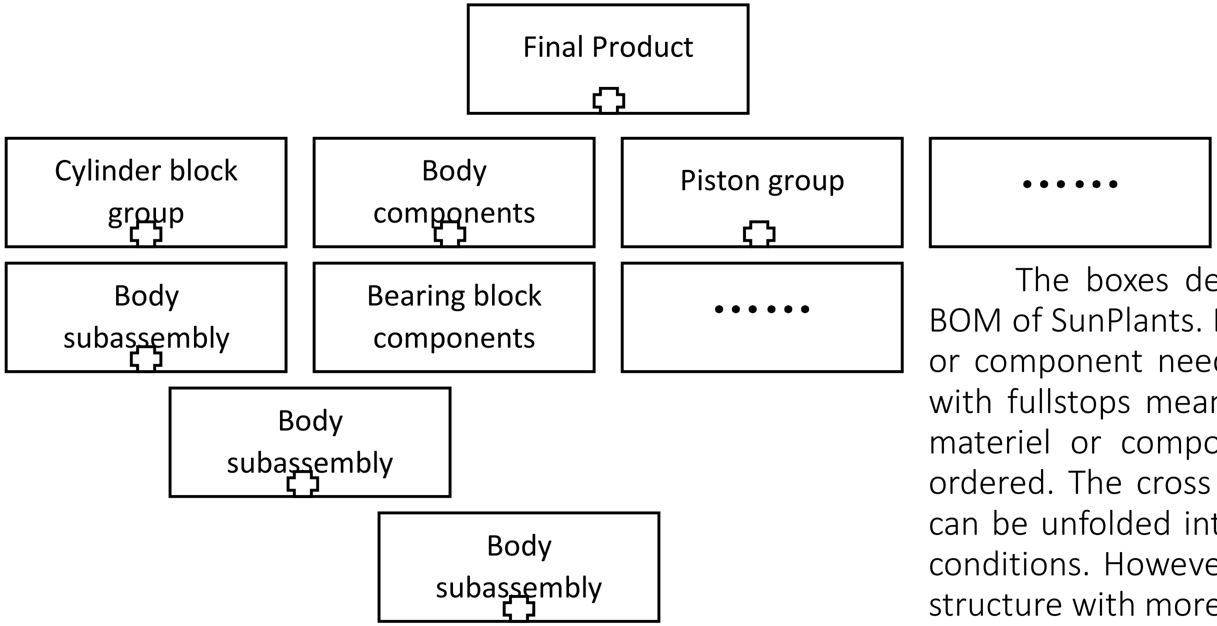
Table 8 Visibility and recognizability associated with the entanglement of accounting, technologies, human actors

	Visibility	Recognizability
Function	• MCS can make deeper penetration into organizational space.	• MCS helps managers know existing action patterns; • MCS helps managers correct action patterns from variance recognized.
MCS	• MCS can produce up-to-date codification and digitalization of data, information, and knowledge; • MCS can visualize all resources and actions.	• MCS can help managers set the accounts and match them to the right categories; • MCS can help managers integrate the accounts.
Digital technologies	• Digital technologies can make MCS easier to collect data and information that monitor production progress, evaluate the processed outcome, and make corrections to the process.	• Digital technologies can support variance analysis of the unacceptable outcomes; • Digital technologies can help to provide sufficient samples for the variance analysis.
Control	• Managers can trace (material movement) processes; • Managers can handle the single actions and simple action patterns effectively.	• Managers can set reliable specification of accountability and responsibility; • Managers can trace a specific bundle of material resources across different spaces and times and among various centers.
Decision-making	• Managers can distinguish a particular resource and action from other material resources and actions; • Managers can quickly modify plans and reset cost targets.	• Managers can select the appropriate patterns in accordance with multiple factors (e.g., order quantity, priority, and resource availability); • Managers can make an accurate plan (i.e., ex-ante decision-making) concerning the amount of resource input and expected output based on the specific action pattern; • Managers can coordinate actions and patterns across different functions.

Table 9 Batch management, technical features, and impact on MCS

Function	Technical features	Impact on MCS
Resource specification	• Resource specification supports identifying a batch (bundles) of materials for specific production actions.	• Resource specification helps to repair control over material resources by specifying and identifying the action patterns with the physical resources movement; • Resource specification helps to rebuild the mechanisms and logics through which the numbers (e.g., accounting number) are calculated and analyzed.
Resource classification	• Resource classification supports recognizing and identifying the transfer of different material resources among different procurement orders, production orders, and various production actions.	• Resource classification helps to provide the basic structure or principle to mobilize the standardized form of material resources management; • Resource classification helps to provide the enhanced structure or principle for centralizing the maintenance of material data.
Batch determination	• Batch determination enables automatic batch creation. • Batch determination provides more effective search techniques;	• Batch determination facilitates the movement of material resources while addressing a material issue (e.g., a material consumption posting to a cost centre), with a stock transfer or with a transfer posting.

Diagram 9 Example of basic BOM of SunPlants



The boxes demonstrate a simple structure of the BOM of SunPlants. Each box represents a kind of material or component needed for a particular order. The boxes with fullstops mean that there would be more kinds of materiel or components to differentiate each product ordered. The cross mark on the box refers that the box can be unfolded into sub-boxes to fit various production conditions. However, the real BOM has a more complex structure with more boxes than this one.

Table 10 MCS practices and the post-upgrading of ERP

ERP Function / MCS Element	Library	Batch Management	Action division	BOM	Data maintenance
Planning	The manager can recognize the patterns and provides decsion alternatives to fit various conditions	The internal process and actions become relatively more transparent and flexible, which forms the basis of the planning flexibility for the reconfiguration capacity	————	The manager can quickly ensure the customer order decoupling point and order consolidation that represents the forecasting or action planning effectiveness of the MCS	Improved data accuracy facilitates procurement plan and inventory effectiveness, which relieves the temporary material shortage
Performance management	————	The manager can trace the final use of one material in critical actions and enhances controls over finished goods	The division and strict exercise of incoming goods inspections facilitate supplier performance management	Improved BOM facilitates the renewal of the feedback mechanism, which reduces the emergent outsourcing that usually lose control	SAP offers a complete mechanism for the storage and maintenance of product design information, which then improve the transparency of R&D performance
Rewards	————				
Administrative	The library is established to tighten the production and R&D actions	————	SAP enables the tight control over critical actions related to the incoming goods, as an initial stage to facilitate inventory control	Improved BOM allows the manager to specify actual processing routines so that both material information and engineering information can be integrated for analysis and stabilizing the production action pattern	A strict data input requirement embedded in the new procedure complements the adding of the actions, helps to ensure the information supply (e.g., information about the inspection), and completes the feedback loop.

Table 11 Examples of the action planning, working procedure, organizational structure, and hybrid measurement systems that were based on ERP

	Example of action planning	Example of working procedure	Example of organizational structure	Example of hybrid measurement systems
Basic form	A well-designed CMPL relates to the well-planned options for selecting the materials/components required and available for the (sales) order	the CMPL is used to guide the design actions as well as the production actions	____	____
Intermediate form	MCS enables the managers to adequately match the financial records of the material resources-related actions with the relevant operational characteristics when managers take action (e.g., production) planning	Managers are enabled to track and monitor the lots during the entire life cycle of the material resources, capturing each lot's unique characteristics (e.g., different expiry dates or dates of production of two lots). Also, SunPlants managers can evaluate the final use of one material in critical actions. Third, the batch number allows SunPlants managers to manage and control some critical business processes	Two actions are divided and coded to support enacting inspection of the incoming goods. The first is coded as "103" to represent "not inspected", and the second is "105" to represent "inspected". These two statuses guide different actions. Adding the "103" stage allows incoming goods to be put in the warehouse that is not accepted. Afterwards, at the "105" stage, the ownership is transferred if the inspection goes through.	____
Advanced form	SunPlants' managers use BOM to specify the elements, hierarchies, and structures of products, and then BOM provides and become a way to improve MCS's item-level visibility when manager make the plan for production actions	At SunPlants, BOM that acts on MCS in terms of visibility and recognizability promotes the reconfiguration of material resources following the actual production and inventory conditions.	Indeed, SAP supports SunPlants to make BOM's structure flexible and reconfigurable to match customer needs, production routings, and the current production capacity… however, BOM's flexibility may induce an inappropriate use of BOM and harm the long-term advantages… improving the transparency and flexibility of the internal process and the generative mechanisms to produce accounting numbers and management information is critical to maintaining long-term advantages	Since data and information are being codified, stored, and connected in a centralized system to reduce redundant and unnecessary information-processing operations and a smoother information flow, SAP enables actors to track the design progress and apply appropriate changes as permitted.

Table 12 Different forms of MCS configuration, visibility, recognizability, and controllability

MCS	Level of complexity of actions and resources that the configuration form faces	The control problem the configuration form solves	Interdependent management control practices involved in the configuration form	Visibility provided by the configuration form	Recognizability provided by the configuration form	Controllability provided by the configuration form
Basic MCS configuration	At the level of single resources and actions	The shortage of information supporting managers in allocating resources for single orders	•Action planning •Working procedure	•MCS can help the manager understand the similarities of the resources and the actions involved.	•MCS can offer valid options for resource and action configurations for a particular (sale) order •MCS can illustrate how a specific material resource relates to various actions	•MCS can help managers guide actions throughout the entire lifecycle of a product.
Intermediate MCS configuration	At the level of any group of resources and production and R&D actions	The shortage of information supporting managers in controlling resources for multiple orders	•Action planning •Working procedures •Organizational structure	•MCS can provide the manager with appropriate and clear resources categorization and codification.	•MCS can help to decompose the complex flow into detailed and rational principles, procedures, and steps for concrete actions for multiple orders	•MCS can help managers build proper (digital) linkages or structures between critical actions based on existing structures for particular control problems.
Advanced MCS configuration	At the level of change in resources and actions group	The shortage of information supporting managers in allocating resources for dealing with changes in sale orders.	•Hybrid measurement systems •Action planning •Working procedure •Organizational structure	•MCS can help managers develop and improve product hierarchical structures; •MCS can help to produce additional information sources from new action(s).	•MCS can help managers integrate cross-functional or departmental actions to handle changes in multiple orders; •MCS can help managers strengthen the feedback loop.	•MCS can help managers maintain production efficiency while safeguarding long-term benefits.

Chapter 5. Monitoring, evaluating, and motivating: how management control systems and enterprise resource planning promotes resource orchestration

5.1 Introduction

This third empirical chapter explores how the post-upgrading of ERP leverages the sophisticated use of MCS in new product development practices (NPD) and traces how the leveraging effect enables resource orchestration (RO). According to Abdel-Kader and Luther (2008, p. 3), the sophisticated use of MCS refers to the capability of an MCS "to provide a broad spectrum of information relevant for planning, controlling, and decision-making all in the aim of creating or enhancing value." Presumably, the non-sophisticated use of MCS may embody weak financial control, insufficient information for planning and control, an inability to reduce waste in organizational resources, and failure to create value through effective resource use. Consequently, perhaps only the sophisticated use of MCS could help to develop RO.

In recent years, RO has been introduced as one of the core skills for managers. RO describes how managers extract more value from the firm's resource base (Chirico *et al.* 2011; Collinson and Wilson 2006; Kremser and Schreyögg 2016; Sele and Grand 2016). Existing RO research shows that RO does not merely consist of resources possessing routines (Cui *et al.* 2017; Priem and Butler 2001; Sirmon *et al.* 2011), but involves the structuring routine, bundling routine, and leveraging routine (e.g., Helfat *et al.* 2007; Sirmon *et al.* 2007; Sirmon *et al.* 2011).

According to Sirmon *et al.* (2011), the structuring routine emphasizes the structuring of a unique resource portfolio; the bundling routine refers to the process of building capability through actions in relation to resources, such as stabilizing, enriching, and pioneering; and the leveraging routine refers to leveraging the capabilities in the marketplace to create value. With these three routines, RO makes a distinct move away from the traditional view of operation, which has been described as unresponsive to managerial actions (Lewis *et al.* 2010), and illustrates how the managerial orchestration of resources is a strategic lever for performance gains. The impact of RO is manifest in promoting strict coordination and synchronization of research and development (R&D) and production actions (Carnes *et al.* 2017; Chirico *et al.* 2011; Ketchen Jr *et al.* 2014; Nambisan and Sawhney 2011; Schriber and Löwstedt 2018).

Although RO has a significant role in organizational performance, the effective locus to materialize RO is still unclear (e.g., Sirmon *et al.* 2011). Presumably, ERP and MCS could work together to promote RO. The traditional role of MCS lies within coordinating organizational actions (e.g., Chenhall 2006) and the use of multiple MCS techniques may facilitate RO. Some MCS techniques are used to control a scarce resource and stabilize the resource base, while some are used to bundle resources through enriching new ideas and product development (e.g., Academy of management reviewHenri and Wouters 2020; Carbonell and Rodriguez-Escudero 2013; Davila 2000). ERP may promote the integrated use of multiple MCS techniques that may then enable RO (Chapman and Kihn 2009; Dechow and Mouritsen 2005; Hyvönen *et al.* 2008; Quattrone and Hopper 2005).

However, it remains important to study the relationship between ERP, MCS, and RO, for two main reasons. First, although extant accounting literature highlights the enabling role of MCS in coordinating organizational actions and processes (Barczak *et al.* 2008; Dodgson *et al.* 2006; Durmuşoğlu and Barczak 2011; Nambisan 2003; Stump and Sriram 1997), coordination is merely one aspect of RO. In addition, the MCS-ERP literature does not explicate this coordination role of MCS. Extant knowledge is insufficient to be able to explain how MCS and ERP work together to promote other aspects of RO, such as synchronizing coordinated cross-functional actions and processes leading to RO (Sirmon *et al.* 2007).

Coordination emphasizes how to work together to perform particular resource movements, while synchronization emphasizes working in parallel workflows (e.g., Braganza *et al.* 2017; Mikalef and Pateli 2017; Pezeshkan *et al.* 2016; Prange *et al.* 2018; Zahra *et al.* 2006). RO shows a higher aim of efficiency and cycle time than coordination, stressing the matching of complementary decisions and controls (Sirmon *et al.* 2007). In other words, RO may complicate the use of ERP and MCS.

Little is known about how ERP and MCS work together to leverage the synchronization and then RO. Understanding the RO development process helps to understand how ERP and MCS work together to create a competitive advantage by controlling valuable and rare resources while maintaining the advantage to be further developed, exploited and sustained over time (e.g., Crook *et al.* 2008; Helfat *et al.* 2007; Sirmon *et al.* 2007; Sirmon *et al.* 2011).

Second, existing MCS-ERP studies that focus on the general relationship between ERP and MCS and how the general terms of ERP and MCS work together may not be enough to explain the ERP-based sophisticated use of MCS for RO. This explanation is important in order to address an issue concerning how to rely on ERP to meet operational efficiency and innovation goals when companies are facing drastic environmental changes. This issue has emerged more prominently within China's rapid digitalization-based transformation because it may characterize how to maintain the efficiency of the existing resource base while facilitating innovation to make incremental developments.

This chapter adopts Simons' (1994) LOC framework (i.e., levers of control) to examine the ERP-based sophisticated use of MCS for RO. I have adopted two LOC concepts: the diagnostic lever (i.e., using critical performance measures) and the interactive lever (i.e., identifying strategic uncertainties). These two concepts link the use of MCS between the operational level (i.e., the diagnostic lever) and the strategic level (i.e., the interactive lever). These two concepts also embody how MCS is used in a complementary manner, and how this complementary use helps to develop RO by facilitating innovation and strategic renewal, on the one hand, and predictable operational goal achievement on the other (e.g., Arjaliès and Mundy 2013; Kruis *et al.* 2016; March 1991; Raisch and Birkinshaw 2008). Grabner and Moers (2013, p. 412) state that “MC practices are complements when the benefits of one MC practice increase with the use of (some) other MC practice (and vice versa)”.[102] In other words, LOC helps to capture the mobilization of MCS practices between operational and strategic levels, revealing the essential and distinguishing attributes of the accounting change in the digitalization age.

This chapter focuses on the post-upgrading of ERP and the corresponding MCS changes in NPD practice across production and R&D actions.

In this chapter, planning, cybernetic controls, compensation and rewards, and administrative controls were observed to involve in the leveraging use of MC practices (for details of the MC practices observed, see Table 15 Examples of planning, cybernetic controls, compensation and rewards, and administrative controls that were involved in the complementary use of the diagnostic and interactive levers). According to the existing RO research, the interdependencies of production and R&D functions have become the primary RO source (e.g., Schriber and Löwstedt 2018; Sirmon *et al.* 2011). In practice, the integration of production and R&D is most likely to lead to better NPD and innovation performances (e.g.,Brettel *et al.* 2011; Hill *et al.* 2000; Nihtilä 1999; Prajogo and Sohal 2006). In this way, I can better meet the research objective of this chapter.

Guided by the levers of control theory, this chapter discovers that the ERP-based MCS changes manifest as a complementary relation. This means that MCS changes might not occur in isolation. Moreover, the complementary relationships are shifting across various strategic routines, timeframes, actors, and objectives involved in NPD and are associated with different technical features.

This shifting relationship is embodied as the different ERP-based complementary uses of diagnostic and interactive levers. Subsequently, MCS practices are used for structuring resource portfolios through monitoring resource movement and motivating

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[102] The authors make a note that: “Strictly speaking, in complementarity theory, complements are defined by a non-negative cross-partial rather than a strictly positive one (p. 412)”.

actors' behavior, bundling resources into the NPD capability to meet rapidly customer needs, and leveraging the capability to be distinctive and sustainable through the mutual translation of business and data. Additionally, senior management involvement, the presence of the interactive team and reflective actors may determine the leveraging effect of the shifting complementary relation on resource orchestration.

Based on these findings, this chapter makes three key contributions. First, this study extends the MCS-ERP literature by revealing the shifting complementary relations of ERP-based MCS changes. Existing ERP-based MCS literature does not focus on the complementary use of MCS to delve into ERP-based MCS practices (e.g., Kruis *et al.* 2016), but existing MCS-ERP literature is limited under either abstract MCS terms (e.g., Dechow and Mouritsen 2005; Malmi and Brown 2008) or specific MCS practices (e.g., Chapman and Kihn 2009; Wagner *et al.* 2011). The shifting complementarity relation is based on understanding the diagnostic and interactive levers but is not explicitly studied by prior LOC-based studies.

This contribution is essential to extend the MCS-ERP literature because the shifting complementarity relations explain how various actors (the subjects of the relation) work with ERP to engage in different but congruent decision-making and control practices. The shifting complementarity may suggest that future MCS-ERP literature consider more complex decision-making situations[103] in order to explore how ERP contributes to the concurrent multiple MCS changes.

Second, understanding the shifting nature of the complementarity relation might contribute to the LOC theory because it reveals more concrete and specific terms involved in the decision-making and control process. The terms indicate the different actors involved (e.g., the controlling actors and the controlled actors, interactive team, and reflective actors), the changing control objectives, and the varying timeframe of enacting MCS in establishing the complementarity of the diagnostic and interactive

[103] That is, a setting where not only there is no obviously correct choice but also there are multiple answers that warrant further and more times of experimentation before committing to a single approach.

levers. Developing the understanding of LOC and the levers' complementarity is critical to know how to steer MCS-in-use so as to stabilize the operation or progressively change a company's strategy (e.g., Frow *et al.* 2010; Simons 1994; Tessier and Otley 2012).

While the majority of existing LOC studies have explored LOC in isolation (e.g., Abernethy and Brownell 1999; Bisbe and Otley 2004; Kober *et al.* 2007; Widener 2007), the shifting complementarity is consistent with, and may extend, recent studies that explore the combined impacts of pairs of levers (Mundy 2010; Tessier and Otley 2012). This understanding may suggest that future LOC-based studies investigate how multiple complementary relationships develop between a particular period in order to meet specific business strategies.

Finally, detailing SunPlants' experience of post-upgrading of ERP to promote production and R&D might also have some practical significance. Although the finding is not an ERP project guidance, it indicates those companies that will make the ERP upgrade in order to notice the potential risks of the intense use of formal communication channels. This chapter also characterizes the interactive team as the main force in the SAP-based complementary use of diagnostic and interactive levers and reflective actors as special ERP users, encouraging ERP-adopting companies to find them out from the ERP users. This suggests that senior managers of ERP-adopting companies identify their interactive team(s) and the reflective actors, in order to help the company to make progressive MCS changes leading to better organizational performance.

The remainder of this study is structured into six sections. The next section (Section 5.2) reviews relevant studies suggesting how the post-upgrading of ERP affects the use of MCS for RO. Section 5.3 depicts how LOC is used to theorize and analyze the ERP-based MCS practices in the RO process, while Section 5.4 provides the background of SunPlants' NPD practices. The fifth section (Section 5.5) undertakes case analysis and reports findings. Sections 5.6 discuss the research findings and implications. Finally, Section 5.7 summarizes this chapter and identifies its contributions and limitations.

5.2 Literature review

This section reviews two streams of prior studies to provide a background for exploring how ERP and MCS work together to develop RO. The first stream describes the ERP-based MCS's role in organizational coordination and integration. The second stream depicts how RO is associated with coordination complexities that may challenge decision-making and control practices.

5.2.1 The impact of ERP on MCS techniques to coordinate and integrate organizational actions

ERP's impact on organizational coordination and integration is one central theme in prior studies of ERP application to business organizations (e.g., Feldman and Pentland 2003; Koch 2001). ERP facilitates greater coordination efficiency (Herbert and Seal 2012), by enhancing information sharing and teamwork (Scapens and Jazayeri 2003), moving information out to each individual to act together (Dechow and Mouritsen 2005), enabling a better sequence of functional actions associated with the business process (Grover and Malhotra 1997; Gunasekaran and Kobu 2002; Gunasekaran and Nath 1997; Kettinger and Teng 1998; Liu *et al.* 2016).

Presumably, ERP-based MCS relates to integrating and coordinating action patterns. This kind of integration and coordination occurs across various functional areas within a company (Davenport 1998; Davenport and Short 2011; Hammer and Champy 1995; Koch 2001; Schlichter and Kraemmergaard 2010), however, the existing ERP-MCS literature extensively studies the integration role of ERP in MCS. Subsequently, one weakness of the existing ERP-MCS literature is the unclear understandings of the coordination role of ERP in MCS.

The coordination role is best understood in conjunction with other MCS research areas. Dechow *et al.* (2006) suggest the importance of studying how MCS and ERP affect the coordination of increasingly complex organizational actions. Coordination mechanisms can exist outside of digital technologies (e.g., a meeting that actors attend each week to discuss current projects) (Claggett and Karahanna 2018), but they are increasingly embedded in digital technologies (Aubert and Rivard 2016). Through ERP, the increased digitization of coordination also tends to enforce control scripts that lend structure to the coordination process (Ethiraj and Levinthal 2004). The coordination that is carried out (e.g., what is transmitted, who receives the information, and when they receive it) is often predetermined and embedded in digital technologies (Claggett and Karahanna 2018).

ERP impacts the effectiveness of MCS. MCS is often used to set rigid limits to prevent employees from seeking alternatives that deviate from the expected action patterns that underpin integration and coordination (e.g., Bedford *et al.* 2016; Dechow and Mouritsen 2005; Sprinkle *et al.* 2008; Stede 2000). MCS also offers the rules, principles, and standards to code experience and communicate it, therefore, stabilizing the coordination and integration (Burns and Scapens 2000; Chapman and Kihn 2009; Scapens and Jazayeri 2003). In some circumstances, MCS is used to ensure the accountability of re-organized actions (Hopper and Major 2007; Merchant and Otley 2006; Quattrone and Hopper 2005). MCS establishes the coordination to adapt the company to a new context by maintaining production efficiencies while maintaining performance (Kruis *et al.* 2016; Mundy 2010; Widener 2007).

ERP acts on MCS by digitizing accounting documents (e.g., invoices), accounting analysis (e.g., large quantities of data from various source systems), and accounting processes (e.g., the automation of routine processes to the greatest possible extent) (e.g., Cohen *et al.* 1996; Davenport 1992; Dechow and Mouritsen 2005). ERP-based digitalization ensures the discretions are afforded (e.g., Conger and Kanungo 1988; Mills and Ungson 2003), enabling decentralized decision-making (Dechow and Mouritsen 2005), and producing ongoing changing loci of control (Quattrone and Hopper 2005).

Additionally, existing studies based on institutional perspectives demonstrate that ERP facilitates the internal development of MCS practices that then facilitate technical coordination (e.g., Granlund and Malmi 2002; Scapens and Jazayeri 2003), such as the configuration of data flows (via the ERP database technology), and the division of planning tasks (via modularization). Existing studies based on socio-material perspectives explore how ERP aligns with large organizations' broader control mechanisms to reach social-technical coordination, such as proper fits between accountability and responsibility (e.g., Dechow and Mouritsen 2005; Quattrone and Hopper 2005; Wagner *et al.* 2011). The socio-material perspectives highlight the inherent complexities of coordination. Moreover, understanding the ERP-based MCS practice for RO requires more effort to explore the coordination issue.

Dechow *et al.* (2006, p. 635) emphasize that the relationship between ERP and MCS should "be untangled rather than to be assumed." However, the existing MCS-ERP literature is not enough to disentangle the assumed relationship between ERP and MCS in coordinating organizational actions. Existing studies, especially those based on the socio-material and institutional perspectives, are concerned more about the impact of ERP on organizational routine (e.g., Dechow and Mouritsen 2005; Granlund and Malmi 2002) than prespecified structured coordination.

Structured coordination enhances individuals' understanding of the overall process and their role in the process (Hoffer Gittell 2002), however unstructured coordination is not determined in advance by routinized processes (e.g., Franke *et al.* 2013; Gomes and Dahab 2010; Obstfeld 2012). Unstructured coordination is driven by emerging aspects of the situation and determined by the actors involved (Claggett and Karahanna 2018). Rich unstructured coordination requires complex information processing, decision-making and control (i.e., MCS) (Gomes and Dahab 2010). Otley (2016, p. 45) demonstrates, "the rapid pace of change and the addition of new or amended systems at a faster rate than the coordination process can develop." In other words, the intense focus on the impact of ERP on organizational routine may not be enough to explicate how ERP-based MCS affects organizational coordination and addresses complexities in coordination.

Indeed, RO is associated with coordination complexities. Existing MCS-ERP research does not address how ERP-based MCS addresses these complexities. There may be two reasons. At the initial stage of ERP-MCS research, the authors may generate an overview of the ERP-MCS relationship. Simultaneously, the coordination complexities may be less critical, and an intense focus on the coordination complexities may be enough to meet the complexity of the overview. Another possibility might be that ERP-based MCS practice was not involved in, and would have only minor impacts on, the coordination complexities. For example, ERP might merely be an information-processing tool for MCS in the earlier stage.

Having discussed the general impact of ERP on MCS techniques to coordinate and integrate organizational actions, a natural related question arises: how does ERP-based MCS practice affect the coordination complexities? The next section depicts how ERP-based MCS practice would affect RO that is characterized as having more complicated coordination patterns.

5.2.2 *The impact of ERP and MCS on RO*

The above literature directs this chapter to understand how managers use MCS to address coordination complexities. Presumably, RO involves the ERP-based sophisticated use of MCS to cope with complicated coordination patterns. The existing RO literature shows that RO involves coordination complexities regarding complicated decision-making, goal setting, processes, and coordination patterns.

Sirmon and Hitt (2003) show that RO optimizes company performance in making congruent resource investment and deployment decisions instead of maximizing or economizing either decision independently. Charles and Michael (2011) offer the specific mechanisms by which senior managers can orchestrate resources to explore and exploit simultaneously, thus overcoming inertia and path dependence. Baert *et al.* (2016) reveal that eight distinctive resource orchestration subprocesses, grouped into three aggregate resource orchestration processes, enable the development and exploitation of a set of resources and capabilities across a portfolio of ventures. Schriber and Löwstedt (2018) explore how similar and different orchestration modes, respectively, are combined with the concepts of sequencing and balancing.[104] RO's

[104] Sequencing means combining the same orchestration mode, and balancing means combining

complexities are manifest in decision-making (e.g., congruent decision-making), and the use of the resources base and development of capabilities (exploration and exploitation simultaneously), leading to coordination complexities.

Focusing on RO could generate a deeper understanding of the impact of ERP-based MCS practices on organizational performance. RO per se has a considerable reliance on ERP to avoid disorganized actions (e.g., Cui *et al.* 2017; Liu *et al.* 2016; Wales *et al.* 2013), thus streamlining the sequence of functional actions and business processes across departments (Beretta 2002; Bose *et al.* 2008; Gupta and Kohli 2006; Huang and Handfield 2015; Powell *et al.* 2013). Drawing on RO may produce deeper understandings of how ERP and MCS moderate each other (e.g., Chapman and Kihn 2009; Xiao *et al.* 2011), but little is known about how they work together for RO.

Analyzing the use of MCS (instead of MCS techniques) may be appropriate in order to study their relationship with RO. RO focuses on using information, ideas, and revisions moving up and down the organizational hierarchy (Sirmon *et al.* 2011). In RO, greater emphasis might be placed on the use of decision-making and control techniques rather than on the implementation or adoption of new MCS techniques. Existing MCS research has also recognized the importance of studying the use of MCS and their impact on performance rather than single MCS techniques (e.g., Bititci *et al.* 2012; Franco-Santos *et al.* 2012; Melnyk *et al.* 2014; Pavlov and Bourne 2011; Widener 2007).

Focusing solely on particular MCS techniques helps to understand the various roles that management accounting generally plays within a company, and the factors and conditions influencing a particular role (e.g., Brownell 1985; Chenhall 2006; Otley and Fakiolas 2000). However, focusing solely on particular MCS techniques does not help to understand the interdependent effect of MCS techniques on organizational performance and how MCS relates to broader control systems in complicated settings (e.g., Bedford *et al.* 2016; Choi 2020; Malmi *et al.* 2020).

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different orchestration modes to partly offset the opposite effects from prior and subsequent orchestration.

Simons (1994) argued that a company should simultaneously use the MCS techniques, as they are interdependent and complementary in nature. Recent management accounting research demonstrates that in practice, multiple MCS techniques work together in a package form in organizations (e.g., Bedford 2015; Kennedy and Widener 2008; Malmi and Brown 2008; Sandelin 2008). The next section illustrates how multiple MCS techniques (practices) are studied according to Simons' levers of control framework.

5.3 Conceptual framework

This chapter favors Simons' (1994) LOC framework to describe, analyze, and theorize the use of multiple MCS practices for RO. The LOC framework identifies four key control levers: beliefs, boundaries, diagnostic, and interactive levers. Due to LOC's explanatory power in the use of MCS, it has played a prominent role in studying MCS (e.g., Koufteros *et al.* 2014; Kruis *et al.* 2016; Mundy 2010; Tuomela 2005; Widener 2007).

Such four key processes, beliefs, boundaries, diagnostic, and interactive, function to analyze how a company realizes the leveraging of its MCS to its fullest potential using the four levers of control. When the four are mobilized together, they facilitate the implementation and attainment of an organization's strategic objectives (e.g., Henri 2006; Mundy 2010; Widener 2007).

The belief lever consists of an explicit and formal set of organizational statements that managers use to communicate the organization's values and provide a coherent strategic agenda. A boundary lever is established to restrict employees in their search for strategic opportunities. The boundary lever of control is represented by an explicit set of organizational definitions and parameters, commonly expressed in negative or minimum terms. A diagnostic lever occurs when managers compare performance against targets to identify critical exceptions and deviations from plans. Feedback on performance enables managers to adjust their actions when results are below expectations. An interactive lever is a formal process that managers use to better organize strategic uncertainties and to identify opportunities. The interactive lever enables managers to identify challenges to their strategic agenda. Managers combine the four control levers to exert control over attaining organizational goals while simultaneously allowing them to search for opportunities and solve problems (Ahrens and Chapman 2004; Frow *et al.* 2010; Mundy 2010; Simons 1994).

I have adopted diagnostic and interactive levers because managers usually incorporate these levers for the desired blend of innovation and predictable goal achievement (e.g., Bisbe and Otley 2004; Chenhall and Moers 2015; Pešalj *et al.* 2018; Simons 1994; Tessier and Otley 2012). This blend may fit the RO setting. The diagnostic lever involves applying critical performance measures to ensure operational efficiency and compliance. The interactive lever is concerned with how managers focus their attention on strategic uncertainties and enable strategic renewals. This chapter uses the LOC to address how ERP affects MCS for RO in three ways, namely the complementary use of MCS, the use of information in MCS, and the interdependent effect of MCS practices.

First, LOC suggests that the use of MCS is complementary in practice. By identifying the distinction between diagnostic and interactive levers, Simons (1994) states that interrelated MCS practices are used complementarily to maintain the efficiency of operational action patterns and then to support unanticipated innovation in discovering action. Arjaliès and Mundy (2013) reveal the importance of control levers in enabling managers to identify and manage threats and opportunities associated with particular strategies.

LOC prescribes that managers should make an effort to employ multiple controls to direct and empower the subordinates to achieve a range of critical organizational goals (Bradach and Eccles 1989; Chenhall 2003; Dekker 2004; Emsley and Kidon 2007; Langfield-Smith and Smith 2003; Vosselman and Meer-Kooistra 2009). Accordingly, this chapter analyzes how the post-upgrading of ERP enables multiple MCS techniques to complement each for RO.

Second, LOC suggests this research in order to study how the information is used in MCS for RO. Some LOC studies emphasize that the performance effect of MCS depends upon the use of information (Arjaliès and Mundy 2013; Henri 2006; Pešalj *et al.* 2018; Simons 1994), rather than solely on management accounting techniques (Otley 2016). Henri (2006) states that, "When MCS is used interactively, (i) the information generated is a recurrent and important agenda for senior managers; (ii) frequent and regular attention is fostered throughout the organization; (iii) data are discussed and interpreted among organizational members of different hierarchical levels; and (iv) continual challenge and debate occur concerning data, assumptions and action plans" (p. 533). Accordingly, this chapter analyzes how the post-upgrading of ERP affects the role of information in the complementary use of MCS for RO.

Third, LOC highlights the importance of the interdependent effects of MCS practices on organizational performance. The LOC framework helps to understand the individual effect of diagnostic and interactive levers (i.e., uses) separately and their collective effects (Bedford 2015). Henri (2006) suggests that when explicitly examined, the diagnostic lever is expected to negatively influence organizational performance, while the interactive lever is expected to positively impact organizational performance. Baird *et al.* (2019) reveal that the use of enabling controls is directly associated with organizational performance and with three management innovation dimensions (new structures, processes, and practices), while the use of constraining controls is indirect, through the adoption of new management techniques associated with organizational performance. In summary, this chapter analyzes the interdependent effect of the complementary use of MCS to understand the performance effect of ERP-based MCS for RO.

5.4 The R&D and production at SunPlants

This section characterizes SunPlants' RO by providing the background to its R&D, production, and NPD practices. SunPlants' customer-driven NPD strategy is portrayed as being enabled by a digitalization-based orchestration process. SAP benefits the orchestration process in terms of the integration of R&D and the production process, NPD quality control, and the communication mechanism for NPD-related actions.

SunPlants has mainly adopted a customer order-driven NPD strategy over the last 10 years. NPDs at SunPlants, which were based on market orders and customer needs, accounted for about 95% of the R&D business. NPDs that were not required by customers merely accounted for about 5% of the R&D business. This strategy allowed SunPlants to avoid too many failed prototypes, adapting faster to the market, and leading to improved financial performance.

In 2015, SunPlants finished specifying three product categories to sustain its customer-driven NPD strategy. The renewed NPD strategy corresponded to a “Plan for Industrial Transformation and Upgrading (2011-2015)” by the Central People's Government of China.[105] The first product category aimed to be a domestic product pioneer and had a considerable market share in the international markets. This category required managers to allocate resources for independent product development and production. The second product category aimed to retain a leading position in the domestic market, whereby managers allocated resources for joint product development with other partners and independent production. The third product category aimed to reach considerable market shares domestically. For this category, managers pursued improving resource efficiency and product quality. These three product categories helped SunPlants to shape the NPD strategy by developing derivative product development, refining, and improving selected performance dimensions to better meet the needs of specific customer segments.

The renewed NPD required SunPlants to facilitate the interdependency between R&D and production actions. At the time of the interview, the interdependency benefited SunPlants, embodying its RO. Digitalization characterizes the interdependency as described as follows.

The digitalization-based interdependency started when the marketing staff had signed the (sales) contract. The marketing staff entered the contract information via SAP and transferred the information as a sale order. The new sale orders were transformed into

[105] http://www.gov.cn/zwgk/2012-01/18/content_2047619.htm

a monthly production plan by the central planning department. Based on a monthly production plan, the marketing, production, and R&D departments then held a coordination meeting. The meeting helped to ensure and specify the product types, quantities, and production sequences, producing a monthly production operation schedule via SAP. With the monthly production operation schedule, the actual NPD process began.

Next, the R&D department designed the product based on specific customer needs. R&D staff made and transferred the drawings and customized BOM to the production department, which would fine-tune the BOM, creating a single planning order based on the customers' needs. Subsequently, SAP would unfold the BOM, offering (analytics) advice for self-made parts. Based on the advice, production planning staff transformed the planning order into a production order, sending the order to the production department.

The data, information, and documents (i.e., a sales order, monthly production plan, monthly production operation schedule, the drawings and customized BOM, single planning order， advice for self-made parts, and production order) were produced, transferred, and handled digitally via SAP. The digitalization ensured the effectiveness and efficiency of the orchestration process.

SAP enabled SunPlants to maintain a shorter delivery cycle for new products. This delivery cycle was composed of seven main stages: conceptual design, preliminary design, detailed design, production routing design, product production, testing and debugging, installation, and maintenance. At the time of the interview, the product development cycle was approximately 30 days, shorter than the industrial level.

One of the notable features was that SunPlants could conduct mirroring tasks by identifying duplicated component designing tasks. For example, the cooler of the GF02 model was identified as being the same as that of the GF04 model. In the R&D process, the cooler of the GF02 model was completed when the cooler of the GF04 model was actually completed. Conducting mirroring tasks contributed to a shorter NPD cycle.

Additionally, SAP contributed to the NPD quality control. SunPlants had a unique and tight NPD control mechanism covering the entire NPD process that started from design input to the final off-site inspection and acceptance. The R&D managers would track and handle the NPD process as a whole. The production department could only conduct the production process according to the R&D requirements. Any change must then be approved by the R&D manager, followed by a special design change process.

Furthermore, SAP built an effective communication mechanism for NPD tasks. R&D software was significantly integrated with SAP and managers could check the current production status of particular new products. SAP could also effectively process data and information of a specific NPD project, producing timely progress reports to managers. The R&D department and other departments had data exchanges, mainly through drawings, process cards, and task notices. Most intra-company communications were based on the form of workflow carrying the data exchange business.

Such SAP-based communication mechanism supported SunPlants to effectively capture individual NPD (or R&D) change. There were three main R&D changes: changes proposed by the production line, changes proposed by the customers, and changes proposed by the R&D department due to technical improvements. Any NPD change triggered the creation of a change request notice via SAP. The production department, the marketing department, and the R&D department could all make a change request notice. When this was submitted, the ERP could automatically provide the sales information, inventory information, and purchase information relevant to the change.

When the change notice request was sent to the approval committee, the committee made decisions based on the evaluation report offered by SAP. The evaluation report would describe the current status of the production component and the possible impact of the changes. The approval committee was a virtual team, the members being from production, procurement, marketing, accounting, and R&D.

Moreover, SAP could collect cost changes induced by R&D changes. Before determining the change, SAP could identify the relevant people who needed to go through the next workflow. SAP would suggest this in the notification about how to deal with the replaced components. SAP would then pass the result of the change to the relevant business department for sign-off.

In summary, SAP played an essential role in the process integration, control, decision-making, and formal communication of NPD practices, enabling the SunPlants' RO to deal with the changing markets and customer needs. We can clearly see the notable benefits of SAP to SunPlants' RO, however the process in which SAP developed the RO was arduous. The next section describes how significant effort and energy were involved in this process over a period of time.

5.5 Case analysis and findings

We now explore how the post-upgrading of ERP leverages the sophisticated use of MCS in new product development practices (NPD), and traces how the leveraging effect enabled resource orchestration (RO). RO consists of the structuring routine, bundling routine, and leveraging routine, and the process is composed of four parts. The first part (Section 5.5.1) describes how the ERP-based diagnostic lever works effectively in structuring a company's resource portfolio. The second part (Section 5.5.2) depicts how the post-upgrading of ERP interconnects with the complementary use of the diagnostic lever and interactive lever in order to bundle resources into capabilities. Next, Section 5.5.3 details how ERP-based complementary use of MCS leverages the capabilities to realize competitive advantage.

5.5.1 *The structuring routine and diagnostic lever*

This section illustrates how a diagnostic lever was constructed through SAP-based PMS and became the basis of RO's structuring routine. The findings reveal that the diagnostic lever is involved in the interconnectedness of technologies, information, and accounting. This connection represents the technical, organizational, and institutional aspects of organizational coordination, and forms the basis of the structuring routine by monitoring, motivating, and rewarding organizational actions.

5.5.1.1 *Performance monitoring at the shop floor level by data*

SunPlants considered the progress monitoring function as an essential part of the PMS. According to Table 13, the progress monitoring function offered progress and performance information, carefully monitoring the movement of organizational resources. Based on such information, managers could have enacted PMS diagnostically (i.e., using the diagnostic lever) to allocate resources, coordinate actions, and motivate the controlled actors' behavior to achieve predetermined outcomes (e.g., Chenhall and Moers 2015; Simons 1994; Widener 2007). Before SAP, the situation faced by SunPlants was the following:

> "Currently, there is no PLM or PDM related system, and all [information about] R&D activities and R&D progress is manually compiled… (PIPL 2.5.1)
>
> Manual data collection to organize the [R&D] project is time-consuming and laborious and not effective…. (PIPL 2.1.8)
>
> CProject is expected to integrate with the ERP, for example, to view the current production status of the products designed and developed." (PIPL 2.1.8)

Even with SAP, the diagnostic lever was not merely supported by progress and performance data and information. The interviews reveal that human actors' commitment to the data input and output loop matters in enacting the diagnostic lever's progress monitoring. ERP (i.e., SAP) had an integral role in the data input and output loop to maintain the effective enactment of the PMS:

> "I need the information to trace the progress of the order, and report it to clients or my leader (senior managers) … Before SAP, R&D and production departments mainly collected and calculated the data and information manually, which was associated with lots of errors and sent to me very slowly…" (SP Marketing Manager Dai)

Within this process, SAP built a communication mechanism by incorporating both financial and non-financial performance measures to monitor the progress and performance outcomes of the R&D and production actions. Managers intended to create this communication network to ensure that the actors complied with rules, principles, and procedures. However, at SunPlants, a reliable communication network for order progress monitoring depended upon the actors' commitment to input the data into the system to keep an effective data input-output loop. This would affect whether or not critical information (e.g., net material requirements and production schedules) was generated correctly to make the communication effective.

At SunPlants, such a data input-output loop determined the effect of the performance measures, but ERP was not the only system involved in the loop:

> "We have to send and download all the documents via ERP, but before, we had numerous ways… We still use other tools to serve SAP." (Sales employee Guan)

> "[SAP has made us] to get used to making order notes when processing orders and plans…The notes make more details of an order via unstandardized information." (Production Manager Zh)

Existing research recognizes that the effect of information necessary to improve productivity and progress efficiency lies with those actors who have limited incentives to use it (Bloom and Reenen 2007; Milgrom and Roberts 1990). At SunPlants, those actors were at the lowest level. Conversely, some actors in organizational routines "are usually more empowered than others. They created and imposed rules and artifacts on others, to monitor performance and enforce compliance, to legitimate specific actions over others" (Dionysiou and Tsoukas 2013).

At the lowest level of SunPlants, actors with more powers (e.g., production planners, plant managers) were the controllers (i.e., controlling actors) over others to be controlled (i.e., plant workers). However, before SAP and at the initial stage of the SAP, the latter had less commitment to using the data because what was accountable by them was executing the (production) plan and finishing the task. They considered that their performance was significantly dependent upon their technical skills and experiences rather than how they used data and information:

> "When I just graduated from university and entered SunPlants, I was a trainee in the production line… I was going to do some research based on the machine data to see if I could make an improvement in the routing…However, my master criticized me, saying it was a waste of time, and the focus should be on how to finish the tasks at hand, so I could go home earlier and be paid more." (Production Manager W)

> "No one is willing to use ERP unless it is mandatory." (The Deputy Head of the R&D Institute)

In particular, at SunPlants, actors who were controlled were always those who collected the data (e.g., the production line workers) to report the performance of the machine (e.g., set-up time, uptime), and their actual performance (e.g., actual work shift and working time). For example, in the production line, SunPlants' was working two shifts a day, and most machines were assigned two workers operating one machine in a day. Each worker had to collect and report how the machine operated and worked during their shift. If the workers failed to record and report their performance to managers, managers would not have further information for analyzing the performance of the workers.

Having discussed the process by which SAP enabled SunPlants to construct the progress monitoring function for a short-term assessment, a related question arises: how does SAP enable the performance evaluation process that assesses longer-term impacts? The next section addresses this question by discussing the transformation of performance data into better performance evaluation practices.

5.5.1.2 From performance data to effective PMS

The data input-output loop based on SAP was essential for SunPlants to construct an effective PMS. The SAP-based PMS supported the production and R&D managers to make the production line more transparent and managerial accountability clearer. The PMS also supported allocating resources (e.g., labor, materials, machines) and coordinating action patterns by evaluating the actual performance and outcomes of production and R&D actions. Thus, the PMS helped SunPlants' managers to know the *real* production capacities. They could then better understand how these production capabilities could be (re)structured and accumulated in order to use resources more effectively. However, before SAP and at the initial SAP adoption, the controlled actors thought that data collection was unnecessary, and that too much real data would expose them disadvantageously:

> "Currently, the machine data (such as the machine tool effective running time, shift, etc.) is manually recorded, and the data is not accurate… (PIPP 2.1.2)

> There is no systematic basis for [production] capability assessment. It can only be done by human experience… (PIPP 2.1.2)

> ERP is expected to provide new product trial production progress report and output report and working time report.” (PIPP 2.2.5)

When the old ERP was used, the controlled actors did not collect data through ERP. Although manual data collection met only basic requirements, manual data collection made the loop and the network useless for the diagnostic lever over the R&D and production actions. Such data failed to support an evaluation of the actual performance and outcome of the R&D and production actions. Thus, it was impossible to leverage the real production capacities.

This failure led to both operational inefficiency and strategic incapability. In terms of operational inefficiency, SunPlants production managers did not build the single-loop information mechanism. Ideally, such a mechanism should have offered single bottom-top feedback and enabled the manager to know the operational efficiency to meet the order delivery (i.e., the diagnostic lever used in the lowest operational (plant) level). In terms of strategic incapability, the old ERP failed to support the CEO’s idea to build a double-loop information mechanism to evaluate the progress of the confirmed order, machine health, etc. This idea was focused on SunPlants’ strategic adjustment in the production line and operational optimization by enabling the production capacity to be shared externally.[106]

For example, when there were no plans to use particular resources (e.g., machines, workers, and designers), the resources could be shared or outsourced. Sharing the capacities externally not only aimed to produce an additional profit source but provided access to additional data and information so as to make the action patterns more adjustable under various conditions. SunPlants could make frequent and accurate (re)planning and semi-real time progress evaluations.

Dechow and Mouritsen’s (2005) research reveals that the ERP works reasonably well at the lowest level of the plant, where it is possible to access specific data on the

[106] A platform has been established for sharing the technicians and machines.

maintenance cost, for example, of each machine individually. However, SunPlants could not use the old ERP to work to a satisfactory degree that met the needs of the strategic adjustment：

> “We preferred using the telephone and coming into the office directly to communicate with others… We needed tools for communication, and [the old] ERP was not the only way…” （R&D Manager H）

Admittedly, ERP supports collecting, organizing, storing, and manipulating data for the diagnostic lever. However, it is clear that the controlled actors, who were not committed to collecting the data, preferred to report positive rather than negative performance. Positive feedback effects lead to competency traps whereby “favorable performance with an inferior procedure leads a company to accumulate more experience with it” (Levitt and March 1988, p. 322).

Indeed, this is not an issue with the technical matters of data collection or technical solutions and tools (Ciborra and Andreu 2002), but are organizational concerns (Wagner *et al.* 2011). The concerns include the actors’ fear of losing their position and job (Scapens and Jazayeri 2003), new centers and peripheries created and recreated (Dechow and Mouritsen 2005), the power of communities of practice (Wagner *et al.* 2011), a residue of the past control structure (Dechow and Mouritsen 2005), various ways to enact control (Quattrone and Hopper 2005), and cultural traditions (unconstrained working times) (Sandelin 2008). SunPlants’ Marketing Central Head said:

> “... they believed that ERP weakened their authority because they and their departments are becoming visible.”

To support the diagnostic lever, ERP is not only about presenting data and information to objectively reflect the reality, but also about providing support for increasing benefits to the various actors within the new reality. ERP should benefit both the controlled actors and the controlling actors alike. The benefits may not be produced merely by the progress monitoring and the PMS:

> “Perhaps [SunPlants] should adopt effective incentive policies to reward those who achieve outstanding results in informatization construction. In the construction of key informatization

> projects, focus should be paid to the introduction of external resources and the formulation of flexible incentive policies for internal personnel." (SunPlants' Marketing Central Head)

In fact, at the initial SAP adoption, some SunPlants actors thought that SAP could not be of benefit to them. Quattrone (2016) demonstrates that "data are not only 'given' but also 'attributed' by those who produce and consume accounting data…Yet, in the digital era, this attribution will possibly become more complex with shifting loci of power and control". Data and information do not merely make things visible but make human actors think about their impacts on the multiple aspects of reality.

Having discussed how merely upgrading the PMS through technological improvement led to failure, a natural related problem arises: has SAP actually improved SunPlants' performance management practices? The next section addresses this question by describing how the progress monitoring and PMS were diagnostically used through SAP at SunPlants.

5.5.1.3 From PMS to diagnostic lever

It is worth noting that SAP failed to construct the diagnostic lever at the initial stage because the behavior of production and R&D staff was not motivated. The adoption of the progress monitoring system gave rise to the drift[107] (i.e., change) in the pay-for-performance relationship. The idea of drift emphasizes that the enactment of the PMS does not merely depend on the technology feature (Wagner *et al.* 2011) due to the non-linear and relational nature of accounting drift (e.g., Andon *et al.* 2007; Burns and Vaivio 2001; Quattrone and Hopper 2001).

Indeed, SAP technologically constructed a new PMS by improving the progress

[107] Quattrone and Hopper's (2001) metaphor of drift indicates the modern definition of change needed replacing by an a-modern definition of drift to act as a proxy for change. The authors demonstrate that: "The idea of drift is preferred to change for some reasons. First, it has no connotation that individuals are sufficiently conscious of space and time to transcend the contingent factors facing them. Secondly, there is no assumption that people move from well-defined situations A or B in a linear, predictable and ordered spatiotemporal framework. Finally, it recognizes contingent factors (such as currents in the sea metaphor) that actors may be aware of, seeks to respond to, but carry them along in unpredictable ways" (p. 427).

monitoring information and information processing capability. The SAP-based PMS assisted managers in knowing the actual working hours of the production and R&D staff and evaluating their actual performance. However, after several months, SunPlants stopped enacting the new PMS in the production line because it led to several strikes by the production line workers:

> "They (the workers) were working longer for lower wages." (Production Manager W)

Before using SAP, the controlled actors often made incorrect or false operation performance reports, where the reported performance was higher than the actual performance, and so the wage paid was correspondingly higher than what was owed. With SAP, more actual, accurate, and objective performance data were collected, thus the wage the actors could gain was reduced. Problems arose not because the SAP failed to build the PMS technologically: if all of the actors were robots, more accurate and timely performance data and reports could lead to better performance.

According to Simons (1994, p. 7), a diagnostic lever should be "used to motivate, monitor, and reward the achievement of specified goals." In the initial period of SAP adoption, SunPlants did not realize that it should consider constructing a diagnostic lever that did not merely consist of progress monitoring technologies:

> "SAP offers more information for decision-making and controls… for example, it helped make the organizational structure business process to change, but it did not create the change…" (SunPlants' Marketing Central Head)

At the initial SAP stage, this PMS did not construct a diagnostic lever partly because the pay-for-performance relation did not change. Subsequently, SAP merely enacted the old compensation system. Although SAP-based PMS had been technologically constructed, a proper modification in the compensation system corresponding to the "changed performance" was absent.

It was impossible to enact the new PMS. As Dechow and Mouritsen's (2005) study mentioned, directly converting old accounting systems into the new ERP would be wrong and hazardous. When SAP began to operate, SunPlants' senior management thought that improving the monitoring information technologies would (obviously) lead to better performance outcomes. However, they did not realize that while they had solved the technological problems, they now faced a situation that technology could not solve. SAP also contributed to technologically synchronizing the wage data and performance data, cutting manual errors that influenced the processes. Insufficient considerations to modify the pay-for-performance relationship led to a failure to enact the diagnostic lever: SAP could not create the modification.

It took several attempts to solve the problem through dialogue across the strategic, managerial, and operational levels. The interviewees emphasized that the board's compensation committee propelled the PMS by developing the wage rates. Growing wage rates rebuilt the pay-for-performance relationship. In addition, the strike ended because the new relationship was stable. The PMS had been maintained for a long time, so rebuilding the pay-for-performance relation newly motivated the employees' behavior. Thus, any technological changes require us to consider whether corresponding social or organizational changes are deserved.

5.5.1.4 *Summary*

Table 13 summarizes the interconnectedness of MCS, actors, and ERP upgrades in the structuring routine. These connections involve issues about the shop floor progress monitoring, performance evaluation systems, and behavior motivation. SAP first built a monitoring function by incorporating both financial and non-financial data and introducing the performance measure into the R&D and production actions. This enabled managers to carefully monitor the organizational resource mobilization in the structuring routine. Managers intended to use the monitoring function to ensure the compliance of shop-floor rules, principles, and procedures. However, although the shop-floor rules, principles, and procedures became computerized, shop floor production staff were unwilling to enter their performance data. Subsequently, the monitoring function initially failed to be digitalized.

[Insert Table 13 here]

This failure to digitalize led to difficulties in upgrading the PMS, which aimed to improve the structuring routine by improving production line transparency and clarifying managerial accountability. Based on the PMS, managers were allowed to know the actual NPD progress and outcomes information in order to evaluate the production and R&D capacity. Managers needed an SAP-based single-loop information mechanism offering shop floor data and information for decision-making. Meanwhile, managers needed an SAP-based double-loop information mechanism that could facilitate coordination and strategic adjustment.

However, the actions of production staff did not align with the managers' data improvement strategy, as they considered that this data strategy caused an (unnecessarily) increased workload and exposed them disadvantageously. The SAP-based PMS failed at the first attempt, even with the technical support of SAP. The failure indicates that the effective enactment of an effective PMS may depend upon how ERP produces mutual benefits to both the controlled and controlling actors alike, as did the progress monitoring function.

The failure of the first attempt led the SunPlants' management team to realize that merely upgrading the monitoring function and PMS did not lead to a better performance of the structuring routine. The SAP-based monitoring function and PMS did not initially motivate shop floor actors' behaviors but simply met managers' information requirements. In other words, the SAP-based diagnostic lever was not built.

However, it was subsequently built after the first attempt to build the progress monitoring function and PMS. The enactment of the diagnostic lever was effective in SAP because the lever not only consisted of the progress monitoring function and PMS but also an improved pay-for-performance relationship at the shop floor level. The effective enactment of the diagnostic lever also implies that the SAP-based diagnostic lever seemed not to simply develop individual MCS techniques but to maintain a dynamic fit between each individual MCS practice.

In other words, Table 13 shows how quality data and information were produced by

SAP, and how the SAP that produced these data could help develop an effective diagnostic lever. Such findings emphasize that SAP (as a representative of quality ERP) may not be equal to the supply of quality data and information. It requires considerable managerial efforts to transform the supply of quality data and information in order to become a factor in behavior motivation.

Having discussed how the SAP-based diagnostic lever could contribute to the structuring routine, a natural related question is: does the SAP-based diagnostic lever, from the LOC perspective, have a limited impact on creating competitive advantages? LOC has emphasized the use of the interactive lever in creating competitive advantages. The next section discusses how the interactive lever complements the diagnostic lever in the bundling routine.

5.5.2 *Interactive team and bundling routines*

This section discusses how SAP has enabled diagnostic and interactive levers to complement each other to construct RO's bundling routine at SunPlants. In this routine, resources are bundled into the capability that meets customer needs. This section has three main parts. The first part analyses how SAP-based planning practices and real-time information work together to bundle organizational actions and resources. The second part depicts how interactive levers have strengthened SAP-based formal communication. The final part provides the summary.

5.5.2.1 *Planning and more real-time information, stabilizing managerial attention*

At the time of the interviews, the diagnostic use of plans and the interactive lever in the form of real-time information were complements used to stabilize production managers' attention when order changes took place. Plans are prospective and retrospective resources for actions (Agre and Chapman 1990). Planning practices are a "prerequisite to and prescribe action, at every level of detail," (Suchman 2006, p. 51) because planning is "an imaginative and discursive practice…. through which actors project what they might do and where they might go, as well as reflect on where they are in relation to where they imagined that they might be" (McKeown 2001, p. 13). When more information and evidence support the plan, actors are more likely to have an effective interaction, facilitate better decision-making, and coordinate a more effective use of resources (e.g., Chong and Mahama 2014; Gigone and Hastie 1997; Mesmer-Magnus and Dechurch 2012).

The interviewees demonstrated that planning was always time-consuming, bringing about coordination inefficiency, even when SAP was adopted. Indeed, planning slows down the decision-making process (Eisenhardt and Tabrizi 1995), especially when a company confronts much more frequent changes than before. More real-time information can be complementary with planning because it is faster to probe, test, iterate, and experience than planning alone (Lave and Wenger 1991).

Such complementary use of planning and real-time information was supportive in stabilizing managers' attention when they were bundling various resources to be capable of meeting customer needs. However, at SunPlants, the complementarity of planning and more real-time information was difficult to achieve merely through SAP. The technological problem (i.e., weak internal networking) was merely one aspect leading to the failure of real-time communication as expected:

> "SAP is powerful, but our server is not ungelivable[108] (bù gěi lì) … The speed [of the internal networking] is as slow as the dial-up networking that we used 20 years ago." (*SP CFO*)

No matter how compelling SAP was intended to be, SunPlants technologically constructed a diagnostic lever; that is, a formal set of MCS practices based on SAP. SAP supported the formal set of MCS through communication channels based on rigid working procedures. In this way, periodical reports were produced for managers for decision-making and control. The interviews reveal that SAP may not be completely equal to better communication: the SAP used by SunPlants offered structured communications, however, the server restricted its communication speed.

Nevertheless, MCS based on rigid working procedures and periodical reports is

[108] A recently popular slang in China, which means something is weak and not supportive. In this sentence, it means internal networking speed is rather slow and weak.

insufficient to save and stabilize managers' attention (e.g., Merchant and Van der Stede 2007; Otley and Emmanuel 2013; Simons 1994). Routines change in a path-dependent manner highlight the importance of feedback effects (Becker 2004, p. 653), however, at SunPlants, frequent feedback and interactions did not run through SAP:

> "Communication via SAP takes much [more] time… not merely because of the technical factors… for example, sometimes one key person [within the communication network] is not in the company…" (R&D SP CFO)

However, at SunPlants, the diagnostic lever that was constructed in SAP did not meet the need for frequent feedback and interactions. Insufficient frequent feedback and interactions contributed to ineffective coordination that distracted managerial attention in the bundling routine. Hence, additional forms of real-time communication tools were adopted to enable frequent feedback and interactions (for details, see the next section).

It seemed that although the SAP-based formal communication channel supported the diagnostic lever, it was assumed to induce communication inconvenience leading to control ineffectiveness to some degree. On the other hand, some critical ERP users did not think the inconvenience and ineffectiveness were extremely troublesome. For example, R&D managers H and Zh thought they had allowed for this, and R&D employees S and Ou felt that they could not work well without SAP. They considered that SAP was a critical and non-substitutable attention-stabilizing tool. Indeed, it was the frequent feedback and interaction that complemented SAP, which supported SunPlants managers in controlling a larger set of actions, focusing more on threats and opportunities that currently underpinned the strategies.

Having discussed why and how SAP-based planning practices needed real-time communication that was built externally to SAP, one related problem is how to promote the use of both SAP-based formal communication and informal communication based on other means. The next section addresses this problem by describing how frequent feedback and interactions were developed through SAP in conjunction with other means.

5.5.2.2 *Formal communication and interactive control, effective goal diffusion and idea enrichment*

Formal communication is key to the diagnostic lever and the interactive control in the form of frequent feedback, while interactions are complements. They are used to make effective goal diffusion and idea enrichment (e.g., Arjaliès and Mundy 2013; Bedford *et al.* 2016). At SunPlants, SAP did not enable frequent feedback and interactions directly but constructed a mechanism allowing for the informal communication channels that were necessary. The informal communication channels were built outside of SAP but offered additional forms of real-time communications. In this way, as shown in Diagram 10, managers became effective at diffusing organizational goals in their explicit form, and their work was consequently enriched with new ideas.

[Insert Diagram 10 here]

Communication problems are common in modern companies due to rapid development and decentralization (Bacharach and Aiken 1977; Elving 2005; Fenton-O'Creevy 1998). “Communication and collaboration tend to become trapped in functional, product, geographic, or other silos” (Vermeulen *et al.* 2010, p. 2). Regarding the solution, “at least for the near term, employees cooperate along with both informal and formal networks…[and] use informal networks to compensate for the limits of the formal structure” (Vermeulen *et al.* 2010, pp. 3-4). Moreover, informal communications exist in well-structured routines because numerous spontaneous and unprogrammable local adjustments are needed to assure elevated levels of coordination, interactions, and control:

> “We used such [an informal communication] tool [109] (e.g., Dingding, Wechat, and RealTimeeXchange) to communicate with the R&D and sale departments when there were multiple sizes and various materials to select and decide upon”. (Production Staff L)

[109] These kinds of software and tools have become the most popular real-time communication and networking applications in Chinese industrial domains.

Additional real-time communications were embodied by using informal communication tools. These tools constructed the interactive lever by providing managers with timely exchanges and the chance to discuss managerial and operational information. Subsequently, managers retrieved the relevant data and information from SAP for decision-making, then translated their decisions into the plan or other formal forms via SAP.

The interactive lever based on the informal communication tools has complemented the SAP-based diagnostic lever. Based on existing research, some external supplements external to the ERP are necessary (e.g., Dechow and Mouritsen 2005; Granlund and Malmi 2002; van Roekel and van der Steen 2019). At SunPlants, SAP did not offer frequent feedback and interactions at the lower levels of the company. SAP did not completely diffuse organizational goals in explicit forms, nor did it effectively translate the goals at lower hierarchy levels to all company levels. All goals could not be communicated simultaneously through SAP, thus informal communication channels became a substitute for real-time goal communication.

At SunPlants, setting goals at lower levels frequently occurred. The lower the hierarchy level, the more frequently the feedback occurred. Although not all of the controls in production and R&D actions were operated in SAP, most were interdependent with SAP so as to facilitate effective MCS enactment to support action coordination:

> "SAP facilitates coordination between different departments… We have a huge reliance on SAP… For example, when the source information is accurate, we can produce the plan directly… In the past, the old ERP systems merely recorded data and information but did not offer feedback…" (Production Manager L)

A large blackboard in the production department office was used to display the plan execution schedule provided by SAP. The blackboard supported the planning and production managers in coordinating the order flow and releasing action (production) plans. Four head controllers also worked with SAP in the office, with constant attention on the screen. Simultaneously, they often made calls to others, inquiring about information, producing and confirming, and fine-tuning the plans.

Those actors who communicated with the planning and production managers formed an interactive team, which shared ideas, information, and suggestions in conjunction with the complementary use of the diagnostic lever and interactive lever. The interactive team established excellent coordination within the SAP by hierarchical and vertical communications. This coordination also relied on how peer-to-peer communications complement hierarchical and vertical communications. The interactive team promoted continual challenge and debate of the underlying data, assumptions, and action plans. In this way, coordination did not merely meet the operational efficiency targets, but scope for new ideas to emerge from lower levels emerged in the process.

The interactive team could make new ideas to communicate at a lower level. In the production office, all of the production controllers frequently telephoned both R&D and sales staff. These interactions aimed to identify and solve uncertainties or changes relevant to the sale and production orders that occurred. In such an interaction process, they (i.e., the production, R&D, and sales staff) often used digital codes rather than literal codes to present a particular material, routing, product, and customer. SAP enabled SunPlants to develop the interactive lever by offering relatively consistent semantics and connotations. The managers used numbers or codes to materialize open dialogue, an ideas exchange, and frequent feedback, which facilitated collective decisions regarding possible opportunities.

The SAP-based diagnostic lever also guaranteed the relevance of informal communication to an ideas exchange and plan (re)formulation. These tools were necessary in frequent feedback and interactions, but not all informal communications were relevant to an ideas exchange or a plan (re)formulation. Disorganized interactions and communications are an inefficient use of organizational resources, making MCS ineffective. For example, work-related communication may turn into a casual conversation related to shopping or a trip. SAP solved the problem of ineffective and irrelevant interactions and communications by tightening the formal workflow, depicted as a sequential process of actions and operations:

> "Most business communication is communicated through workflow… The subsequent workflow

can be configured flexibly, and the node can be set according to the position". (PIPP 2.1.1)

The interactive lever and the interactive team entailed additional forms of real-time communication to remedy the communication inefficiency of the SAP-based diagnostic lever. Meanwhile, the SAP-based diagnostic lever constructed consistent semantic meanings and enhanced the relevance of the feedback and interactions. The interdependencies between the diagnostic and interactive levers contributed to resource bundling in isolation and combination.

5.5.2.3 Summary

In summary, this section discusses the SAP-based complementary use of the diagnostic and interactive levers by clarifying three stages (i.e., stage a, b, and c, as indicated in Diagram 10). Within stage a, SAP constructed the planning-based diagnostic lever through rigid working procedures and periodic feedback. This type of diagnostic lever was established at the initial stage of SAP adoption. However, the SAP-based formal planning practices could not promote SunPlants' planning capability able to support rapid changes in the plan. The interactive lever, in the form of open dialogue, ideas exchange, and frequent feedback, complemented the diagnostic lever. This complementary relationship enabled managers to continue to reformulate the production plans at the operational level. Continuous reformulation of the production plans stabilized managers' attention from the external changes, allowing them to implement a business strategy.

Later, within stage b, the diagnostic lever gradually became more effective. The SAP-based diagnostic lever started to produce and offer consistent semantics and connotations across the overall organizational communications. However, the diagnostic lever had a limited impact on diffusing organizational goals in explicit form. At this stage, some additional informal communication tools were adopted to enable effective communication and coordination at the lower levels of SunPlants.

After stage b, the autonomous formation of the interactive team appeared in stage c. The interactive team facilitated the performance effect of the diagnostic lever by enabling the use of consistent semantics and connotations in the mutual translation process of data and business. The interactive team building was a kind of by-product of SAP adoption, promoting the use of data and information formally and informally in decision-making and controlling practices. In turn, the interactive team contributed to resource bundling performance in conjunction with the complementary use of the diagnostic and interactive levers. Then, the interactive lever was promoted to translate the goals at lower hierarchy levels to all company levels. SunPlants managers' works were enriched with new ideas, enabling bottom-up innovation.

In other words, according to Diagram 10, this section reveals how the SAP-based complementary use of diagnostic and interactive levers grouped organizational resources together for more effective handling, in order to develop capabilities that gave SunPlants a competitive advantage.

Having discussed how the ERP upgrade enabled MCS to develop the bundling routine that transforms resources into the capability that rapidly handles customer needs, a natural related question is: how did capability become the distinctive one to continue functioning over a while? The next section addresses this question by explaining how the diagnostic and interactive levers continued to work to enable the leveraging routine at SunPlants.

5.5.3 The leveraging routine and reflective actors

This section investigates how SAP-based MCS contributed to the leveraging routine to create competitive advantages by synchronizing actions and deploying organizational resources.

5.5.3.1 Mutual translation of data and business

According to Sirmon *et al.* (2007) and Chirico *et al.* (2011), RO involves synchronizing organizational actions to leverage organizational resources so as to develop a distinctive capability leading to the desired strategies. Indeed, ERP is believed to be a technology to "create synchronized and streamlined data flow (internal and external)" (Powell *et al.* 2013, p. 331). SAP has enabled MCS to support such synchronization:

> "[When compared with the old ERP], the SAP system is rather compelling and is ideal for managing R&D with complex processes, especially for the context where there are more than 1,000 people engaged in production and R&D activities. SAP keeps the R&D actions in a routine, preventing developers from focusing too much on their personal situations and ignoring the entire progress of the project". (The Deputy Head of the R&D department)

> "Dealing with the sales orders was rather time-consuming with the old ERP … The production department was always waiting for us… SAP helps us avoid lots of errors made by manual order processing." (SP Marketing Manager Dai)

SunPlants adopted the PLM (product life cycle management) module in SAP. PLM enabled the diagnostic lever to be configured for each specific product category (as discussed in Section 5.4). In this way, nearly all of the actions involved in the product life cycle were monitored. Nevertheless, this was the initial step, and more efforts were needed to synchronize the development of distinctive capabilities.

At SunPlants, the interviews indicated that the marketing, R&D, and production actions required information exchange within the PLM module and SAP. Information exchange via SAP also formed the basis of frequent communications and interactions between the actors of the three primary departments (e.g., marketing, production, and R&D departments).

In this way, SunPlants could synchronize information between these three departments. This synchronization supported effective sales order decoupling and consolidation (points). Based on these points, managers became more effective in deploying resources through maintaining production and operation integration and segmentation. For SunPlants, the benefits of the synchronization were more than ensuring product quality and product delivery efficiency. The synchronization supported managers to leverage the resources through dynamic coordination between the effective segmentation of customers' demands, new product design capacity, and production capacity (see Diagram 11).

[Insert Diagram 11 here]

According to Diagram 11, the solid line represents the ordinary coordination (i.e., sequential communication and interactions) between the marketing, R&D, and production functions. Due to the "manufacturing to order" (MTO) production strategy, a particular production routine started only after receiving a customer's order. The marketing department translated a contract into a sales order to confirm customer requirements. The order was then sent to the R&D department for product design and BOM (bill of material) generation. The marketing department received feedback mainly in the form of BOM via SAP from the R&D department and forwarded it to the production department. The production department then generated the production order specifying the production quantities and dates and sent them to the production units via SAP.

In Diagram 11, the dashed line and the solid line together represent the synchronization (i.e., non-sequential communication and interactions) between the marketing, R&D, and production functions. SunPlants had to continue expanding its production scale by improving production and processing efficiencies. The synchronization supported technological and product innovations to meet market needs. Simultaneously, SunPlants managers had to maintain a forward-looking focus by keeping R&D ahead of their domestic counterparts. The dashed and solid lines together illustrate the coordination complexities.

A mutual translation was needed to address the coordination complexities, which relied upon the complementary use of diagnostic and interactive levers. SAP helped to develop the diagnostic lever by facilitating the use of critical performance measures over actions across the R&D/production loop. In this way, managers were supported to synchronize actions across the entire stages within R&D and production functions:

> "Before SAP, most paper (performance) reports were sent to me… each of them in simple dimensions… I could not combine them into complex dimensions for comprehensive (performance) analysis and decision-making… [However,] SAP makes it possible…" (The Deputy Head of the R&D department)

> "Having SAP is much better than having no SAP… I have huge information needs in my daily work… The function of SAP is logically amendable if necessary… much better than papers…"

(Marketing staff Tian)

The synchronization was possible because the SAP-based diagnostic lever became effective in penetrating the processes and actions. Managers could make each process and action calculable and accountable. The diagnostic lever offered managers more quality data and information during their interactions. Managers became more reflexive and effective at translating the business into data and information. For example, the evaluation of production capacity and processing technology performance was performed so as to schedule production orders faster and more flexibly, which was the foundation upon which to leverage the resources. However, this merely enabled the translation of business into data and information.

Moreover, synchronization also needed the interactive lever to translate data and information into the business. Based on SAP, the interactive lever mobilized this translation:

> "[Orchestration] is not taking a bunch of data and analyzing them all together…[SAP] supports the translation of business into data by people". (GoSoft Associated CEO QX)

At SunPlants, the use of SAP in the interactive lever did not merely manifest in the increased interactions of senior management and operational managers. SAP per se also consisted of multiple special modules, which provided frameworks or agendas for debate, motivating information gathering outside of routine channels. Notably, the proper use of SAP offered a framework to enable the managers to produce non-standardized assessments.

Having discussed how the SAP-based mutual translation of business and data formed the foundation of synchronization to leverage the organizational resources, a natural related question is concerned with how to continue the effective mutual translation. The next section addresses this question by exploring how the synchronization continued to develop at SunPlants.

5.5.3.2 *Ongoing mutual translation*

The synchronization between the R&D and production actions to leverage the resources did not merely depend upon SAP. It also relied on a sophisticated use of MCS; that is, the extensive use of MCS based on their complementary relationships. However, at that time of the old ERP, the MCS was not sophisticated. An example is the cost collection of the NPD cost:

> (i) The price of raw materials is inaccurate; (ii) the monthly weighted average price is calculated manually; (iii) the cost of raw materials is derived manually and calculated by manual matching; (iv) the price of self-made parts is calculated manually; (v) the price of self-made parts depends on manual calculation; (vi) the apportionment method of labor and cost is rough and inaccurate. (PICO 3.2.1)

The extensive use of MCS (e.g., more complementary relationships) by SunPlants' SAP users was critical. In particular, the use of MCS became extensive when more reflective actors appeared. SAP users became increasingly reflective actors, engaging in progressive MCS changes. Before SAP, they were simply passive actors,[110] executing the plan and order. Reflective actors refer to those who are thinking deeply about and engaging in progressive revision, modification, and change of MCS. With appropriate digital technologies (e.g., ERP), the reflective actors are concerned with *how* others have done the job rather than *what* they have done (the term "reflective actors" is explained later in this section).

The synchronization embodies the "post-adoption success" of ERP, during which the ERP is not merely the tight integration of business functions into a single system (Newell *et al.* 2003). At SunPlants, SAP was involved in every organizational resource and RO actions:

> "By splitting the master data of the assets, the asset (quantity) corresponds to the specific cost centers; (PIFI 5.1.1.1)
>
> Assets can be more finely classified; (PIFI 5.1.1.2)
>
> The approval process of asset purchase, maintenance, scrap, loan, lease, and sale has been realized; (PIFI 5.2.1.1)
>
> Real-time integration of asset status in asset cards, such as maintenance record, scrap, loan, rent, and sales record has been realized; (PIFI 5.2.1.3)

[110] Passive actors refer to those who do not take action (e.g., the engagement in progressive revision, modification, and change of MCS) but instead let such things happen to them.

> According to the different production batches, different routings are selected, which mainly affects the arrangement of machines." (PIPP 2.1.3)

ERP should have acted on the actions and resources. SAP made MCS gradually reflective, with increasingly reflective actors engaged in progressive revision, modification, and change of MCS. These actors continued to incorporate both informal and formal communications for frequent feedback and interactions to leverage resources and actions. It is worth noting that although SAP was successful at SunPlants, the company still adopted other information systems, externally interdependent with SAP (e.g., PDM, MES, and DNC).[111] Their interdependencies facilitated SunPlants to develop the synchronization of R&D and production. When managers were afforded more useful data and information, they would encounter more "problems and challenges" with business models, working procedures, and organizational structures:

> "Changes in the material are frequent… the data needs maintenance… SAP is a massive system involving lots of people to operate…For example, some R&D employees did not modify BOM when relevant material changes took place… [In the initial stage of SAP adoption] they shied away from such responsibility because any BOM modification brings with its accountability concerns… In such a situation, they always sent us a letter of notice for a temporary change in material(s)… This "tip" formed a trap to affect data quality… moreover, we veterans know such tips and traps, but the newly employed planner is not familiar with them, [and] sometimes huge mistakes took place." (Production Manager L)

The post-upgrading of ERP made the reflective actors more concerned with *how* others had done the job rather than *what* they had done. After SAP adoption, data and information maintenance and working procedure improvement became routine tasks associated with the leveraging routine. These routine tasks could ensure that MCS could be quickly revised, modified, and changed when the MCS enactment problem arose. The maintenance and improvement did not rely on SAP per se.

SunPlants' CEO emphasized the importance of the reflective actors in system maintenance and improvement. SunPlants' senior management believed that the SAP project would never satisfy the reflective actors to develop RO. The Clouding project

[111] Product data management (PDM), Manufacturing execution systems (MES), and Distributed Numerical Control (DNC).

was initiated at SunPlants. This project aimed to offer reflective actors physical information produced by machines at the production line, which would help the reflective actors to build an effective diagnostic lever for the production machines. The reflective actors would use such information to strengthen the diagnostic lever to leverage the resource by knowing and handling the synchronization of the machine's operations.

The production machine is a core resource in manufacturing industries, however, traditional accounting has difficulties in managing it. For example, the remaining value of a machine is calculated by its depreciation in accordance with arbitrary rules (e.g., straight-line, declining balance, double-declining balance, sum-of-the-year's-digits, and units of production). Instead, the diagnostic lever based on traditional accounting measurement could not capture the machines' actual usage nor evaluate the machines' capabilities. The traditional accounting value of the machine could not exact more benefits for SunPlants.

In the Clouding project, SunPlants would connect most of its production machines with Clouding technologies by physical data acquisition devices (vibration data, temperature data, and rotate speed data) and engineering data devices (e.g., G-code). With such devices, data could be collected from a machine at the sub-second level, and thus visibility could be produced every second. In this way, SunPlants could manage the machine in conjunction with more intelligent information and analytics.

Most interviewees believed this was necessary to minimize internal disorder and maximize synchronization efficiency.[112] For example, the diagnostic lever could be equipped with technologies modeling the real-time machinery wear rates to improve product quality and delivery efficiency. At the managerial level, SunPlants could have more real-time data to monitor a machine operator's behavior and performance.[113]

[112] During the interview, SunPlants just started using the machine data. There was no evidence regarding the detailed use of the machine data.

[113] Each action of a machine is monitored to reflect if the operator is doing the action in accordance with the standardized routings and working procedures.

Managers could understand how many jobs an operator has achieved, how the operator has achieved the jobs, and how skillful the operator is in doing this job. Such data could be established as reference points for promotion/rewarding and training plans for employees. From the perspective of the interviewees, synchronization was built not just technologically but also organizationally.

5.5.3.3 Summary

Table 14 summarizes how SAP-based complementary use of diagnostic and interactive levers continued to leverage the orchestration. The complementary use of the two levers leads to the dynamic coordination between the customer demands, product, and production, mutual translation of business and data, and reflective actors.

[Insert Table 14 here]

The SAP-based diagnostic lever promoted the orchestration by digitalizing the entire product lifecycle and NPD process. This penetration enabled a dynamic linkage with organizational resources and actions with specific products, which prompted R&D and production to respond to customer needs by rapidly matching the customer needs with the existing resource base. Additional real-time communication based on informal tools also constructed an effective interactive lever that complemented the diagnostic lever. Real-time communication enabled effective frequent information exchange within the PLM module and SAP. This interactive lever helped the SAP-based diagnostic lever develop rapid matching between customer demands, products, and production.

Another critical SAP-based complementary use of diagnostic and interactive levers lies within the mutual translation of business and data. The SAP-based diagnostic lever offered critical measures over the entire NPD process, enabling managers to translate transactions and business into data and reports. An interactive lever that was based on informal communication offered opportunities to generate ideas from the data. Such an interactive lever worked with the diagnostic lever to motivate managers to collect information outside of the routine channel and produce non-standardized performance assessments. The sophisticated use of multiple sources of data and information by managers leveraged distinctive capabilities.

Additionally, the SAP-based complementary use of diagnostic and interactive levers gave some actors a chance to become reflective. These reflective actors maintained the continuous incorporation of informal and formal communications because they relied on frequent feedback and interactions to remain open to new possibilities. They made efforts to maintain the effective digitalization of business processes. Further, they built upon and modified control levers through more intelligent information and analytics.

The involvement of reflective actors is considered critical in the translation process. The reflective actors may not be every SAP user or all organizational actions. Instead, the reflective actors adopted a more sophisticated use of information technologies to leverage organizational resources as opposed to the passive data and information consumers. The presence of some reflective actors per se became a distinctive capability.

Although this case finding section has discussed how the diagnostic and interactive levers work together in three RO routines, there is a lack of understanding of how the SAP-based complementary use of diagnostic and interactive levers evolves within SunPlants. The next section addresses this issue by discussing how complementary relationships shift in three distinctive periods.

[Insert Table 15 here]

5.6 Discussion

Through studying planning, cybernetic controls, compensation and rewards, and administrative controls that were involved in the complementary use of the diagnostic and interactive levers (For examples of these MC practices, see Table 15), this chapter reveals how SAP helped SunPlants to construct MCS to support coordination complexities in R&D and production actions. The research findings reveal the shifting nature of the complementary relations of single MCS practices during the effective MCS enactment. This reveals that a company's MCS practice is made up of single MCS practices that are continuously moving and changing the location of the complementarity that occurs in relation to other parts within different RO routines. The complementary relationships of MCS are neither fixed nor bound to specific forms; however, the relationship is shifting over time and space and across various subjects and objects. Table 16 shows how complementary relationships shift between three periods.

[Insert Table 16 here]

At the beginning of the SAP adoption, there existed a complementary relationship between the SAP-based PMS and the compensation policy modification. This relationship aimed to support the effective PMS enactment in structuring organizational resources and actions by monitoring their movement. However, senior managers stopped enacting the SAP-based PMS because it initially conflicted with the legacy compensation system.

At the initial stage of both ERP adoption and the post-upgrading, tensions may arise, such as that between ERP-induced change and legacy control structure (e.g., Dechow and Mouritsen 2005; Granlund and Malmi 2002; Scapens and Jazayeri 2003; Wagner *et al.* 2011), and several induced strikes at SunPlants production. The new PMS was enacted as soon as the senior managers reconsidered modifying the compensation policy and recreated the pay-for-performance relationship.

In such a shifting process, senior managers, production staff, and production managers were the main subject of this complementary relationship. Their goal was effectively enacting the PMS to motivate better behavior in the production line. This complementary relationship occurred within the diagnostic lever because, as explained by existing research, nearly every actor needed time to adapt to the new socio-material assemblage in the initial stage of the post-upgrading of ERP (e.g., Dechow and

Mouritsen 2005; Wagner *et al.* 2011).

This study reveals how ERP materialized a renewal of the pay-for-performance relationship that underpinned a sophisticated MCS, rather than how ERP enabled the adoption of sophisticated management accounting techniques—some exiting studies have studied (e.g., Granlund and Malmi 2002; Scapens and Jazayeri 2003).

Later, during the effective MCS enactment process, SAP constructed a formal communication channel for incorporating both diagnostic and interactive levers to coordinate cross-functional actions. Formal communication based on SAP could not afford additional forms of real-time communication necessary for effective feedback and interactions (e.g., dialogue and debate). Nevertheless, SAP allowed for the use of informal communication channels by offering rigid working procedures and consistent semantics and connotations.

Existing MCS-ERP studies have emphasized that creating supplements that work around ERP (Dechow and Mouritsen 2005; van Roekel and van der Steen 2019) is a means to offer access to a broader range of views and information and to foster performance (Gebert *et al.* 2006; O'Reilly *et al.* 1997; Woodman *et al.* 1993). In this shifting process, all of the actors involved in marketing, R&D, and production became the subject of this complementary relationship. They aimed to maintain frequent feedback and interaction in order to support effective decision-making and control over the entire NPD process.

This complementary relationship would continue to enable the dynamic fit between coordinated actions. According to existing research, ERP facilitates unprecedented levels of organizational integration (Davenport 1992, 1998; Dechow and Mouritsen 2005) by inspiring minor ideas that come from the actors when they are enabled to have more information retrieved from others.

Third, after three years of the SAP adoption, information gathering outside of routine channels began to complement specific ERP modules constructing an R & R&D-production loop (i.e., PLM). Before this complementarity, SAP had mobilized the promising synchronization logics by modularizing the diagnostic lever across the product lifecycle (i.e., product lifecycle management) in conjunction with other modules and functions, especially material management, production plans, controlling, and digitalized workflows.

The SAP-based diagnostic lever facilitated translating and visualizing business and transactions into numbers and data through performance measures, feedback loops, and rigid working procedures. After approximately three years, the increasing synchronization needs motivated managers to rely on the interactive lever by gathering information from outside of the routine channels. This change in the interactive lever complemented the SAP-based PLM, facilitating the MCS to translate data into the business through developing new business models, working procedures, and organizational structures, enabling existing routines to become proactive and innovative.

MCS change based on this complementarity relationship "follows a distinct learning curve" (Dechow and Mouritsen 2005, p. 729), involving a "particular entanglement of users and technology" (Wagner *et al.* 2011, p. 181), and maintaining unprecedented levels of organizational coordination and synchronization. Within this relationship, the subjects were SAP users, and senior managers, who aimed to promote the mutual translation of business and data. This complementarity relationship continued at SunPlants for several years because the reflective actors needed the mutual translation of business and data to facilitate the synchronization of resources and actions, thus, reducing the decision latency. The shorter the time-to-decision by all managers, the more the value of the information can be gained.

Additionally, the findings imply the importance of technological improvements in the information infrastructure in shifting complementary relationships. In addition, the involvement of senior managers promoted the shifting complementary relationships to enable effective MCS enactment. The senior managers were involved in the complementary relationships to consider the MCS as a whole, as effective MCS enactment was not merely for coordinating single actions, processes, and departments.

The shifting complementary relationships may emphasize the importance of senior management involvement in the non-linear and relational MCS changes. Understanding the non-linear and relational MCS changes is critical in management accounting research (Dechow and Mouritsen 2005; Quattrone and Hopper 2005; Wagner *et al.* 2011). Effective MCS enactment involved multiple actors with different orientations, subjectivity, positions, and disagreed on how to enact the MCS and perform distinct actions and interactions (Howard-Grenville and Rerup 2016), such as the incentive compensation systems (Govindarajan and Fisher 1990; Govindarajan and Gupta 1985). The involvement of SunPlants' senior management lay within both the intra-lever (i.e., components within the diagnostic lever) and the inter-lever level (i.e., between the diagnostic and interactive levers).

5.7 Conclusion

Through studying the case of SunPlants, this chapter shows how the ERP-based non-linear MCS change (e.g., Quattrone and Hopper 2001; Wagner *et al.* 2011) that manifests as complementary relationships (Chenhall and Moers 2015) is shifting (e.g., Mundy 2010). This is because actors using SAP may be committed to be involved in progressive MCS revision, modification, and change. In turn, the progressive MCS revision, modification, and change would continue to support actors in coordinating and synchronizing goals and actions. Coordination and synchronization via ERP or other digital technologies are not merely technological issues, and further organizational efforts are needed.

SAP directly enabled SunPlants to make NPD decisions based on effective formal feedback. Importantly, SAP indirectly enabled the frequent interactions of actors, leading to effective decision-making for RO. In conjunction with the use of additional real-time communication tools, SAP-based feedback and interactions materialized the promising synchronization logics among cross-functional actions leading to RO.

Bhimani and Willcocks (2014) state: "Information that is captured, 'technologized' and 'informated' cannot fully capture tacit knowledge which managers embed in their decision-making styles and which they prefer to further build upon from sources external to structured information processes." SAP 'technologized' and 'informated' MCS practices that provide structured decision-making mechanisms, in conjunction with the use of additional communication tools that mobilize tacit knowledge by offering unstructured decision-making mechanisms. In this way, SAP-based complementary use of MCS could support the structuring, bundling, and leveraging routines, leading to resources orchestration for creating competitive advantages based on operational efficiency and innovation.

This chapter makes three key contributions. First, this chapter extends the MCS-ERP literature by revealing the shifting complementary relations of ERP-based MCS changes. Existing ERP-based MCS literature does not focus on the complementary use of MCS to delve into ERP-based MCS practices (e.g., Kruis *et al.* 2016), but existing MCS-ERP literature is limited under either abstract MCS terms (e.g., Dechow and Mouritsen 2005; Malmi and Brown 2008) or specific MCS practices (e.g., Chapman and Kihn 2009; Wagner *et al.* 2011). The shifting complementarity relation is based on understanding the diagnostic and interactive levers but is not explicitly studied by prior LOC-based studies.

This contribution is essential to extend the MCS-ERP literature because the shifting complementarity relations explain how various actors (the subjects of the relation) work with ERP to engage in different but congruent decision-making and control practices. The shifting complementarity may suggest that future MCS-ERP literature consider more complex decision-making situations[114] in order to explore how ERP contributes to the concurrent multiple MCS changes.

Second, understanding the shifting nature of the complementarity relation might contribute to the LOC theory because it reveals more concrete and specific terms involved in the decision-making and control process. The terms indicate the different actors involved (e.g., the controlling actors and the controlled actors, interactive team,

[114] That is, a setting where not only there is no obviously correct choice but also there are multiple answers that warrant further and more times of experimentation before committing to a single approach.

and reflective actors), the changing control objectives, and the varying timeframe of enacting MCS in establishing the complementarity of the diagnostic and interactive levers. Developing the understanding of LOC and the levers' complementarity is critical to know how to steer MCS-in-use so as to stabilize the operation or progressively change a company's strategy (e.g., Frow *et al.* 2010; Simons 1994; Tessier and Otley 2012).

While the majority of existing LOC studies have explored LOC in isolation (e.g., Abernethy and Brownell 1999; Bisbe and Otley 2004; Kober *et al.* 2007; Widener 2007), the shifting complementarity is consistent with, and may extend, recent studies that explore the combined impacts of pairs of levers (Mundy 2010; Tessier and Otley 2012). This understanding may suggest that future LOC-based studies investigate how multiple complementary relationships develop between a particular period in order to meet specific business strategies.

Finally, detailing SunPlants' experience of post-upgrading of ERP to promote production and R&D might also have some practical significance. Although the finding is not an ERP project guidance, it indicates those companies that will make the ERP upgrade in order to notice the potential risks of the intense use of formal communication channels. This chapter also characterizes the interactive team as the main force in the SAP-based complementary use of diagnostic and interactive levers and reflective actors as special ERP users, encouraging ERP-adopting companies to find them out from the ERP users. This suggests that senior managers of ERP-adopting companies identify their interactive team(s) and the reflective actors, in order to help the company to make progressive MCS changes leading to better organizational performance.

Although I have identified some contributions in this chapter, it is still bound to some limitations. This chapter is inherent with limitations due to methodological and theoretical restrictions. First, this chapter focuses on the two critical functions (i.e., production and R&D) that work together for RO. However, RO involves more than these two functions; for example, warehousing, procurement, marketing, and advertising are also parts of RO, but at the time of the interview, SunPlants' RO for

NPD was merely characterized by the integration of production and R&D functions. More compelling methodological and theoretical frameworks could be considered and designed to integrate additional critical functions to produce a more comprehensive explanation and theorization of the use of MCS and ERP for RO.

Second, this chapter explores a particular NPD setting where product innovations are created and brought to the market for the first time by modifying and improving existing products. Broadly speaking, there are companies involved in two other NPD settings, including products that have never been designed or produced previously but have been taken to market for the first time by rivals with original product innovations. These two settings have distinct patterns by which to orchestrate resources and actions in NPD and production processes, and are associated with various ERP uses to leverage MCS. Future MCS-ERP studies are encouraged to embrace these two NPD settings to examine how ERP-based sophisticated MCS are used and what ERP-based MCS changes occur within them.

Table 13 The entanglement of MCS, actors, and ERP upgrade

	Description	MCS's Role in the structuring routine	The controller actors	The controlled actors
Progress monitoring	• The progress monitoring function helps managers incorporate both financial and non-financial performance measures; • The progress monitoring function helps managers can monitor the progress and performance outcomes of the R&D and production actions.	• MCS can help managers carefully monitor the actions that mobilize material resources.	• Senior managers intended to ensure that production personnel follows the rules, principles, and procedures.	• The production staff had fewer commitments to use and collect the data
PMS	• The PMS supports managers build a transparent production line; • The PMS supports managers build clearer accountability for managers.	• MCS can help managers evaluate actual performance and outcomes of production and R&D actions; • MCS can help managers evaluate the real production capacities.	Managers require a one-loop reporting mechanism to: • Know the operation efficiency. Managers require a dual-loop reporting mechanism to: • Evaluate the progress of the confirmed order, machine health, etc; • Enable the production capacity to be shareable with the external.	Production staff thought: • Collecting data was not necessary; • Too much real data would expose them to a disadvantageous position.
Diagnostic lever	• The diagnostic lever supports managers in motivating the behavior of production staff by modifying the pay-for-performance relation.	• MCS can help managers maintain a dynamic fit between control problems to be solved.	• Production managers needed accurate and objective information on performance.	• Production staff needed higher salaries.

Diagram 10 Different stages of the bundling routine, communication and interaction effectiveness, and complementary relations of the control lev

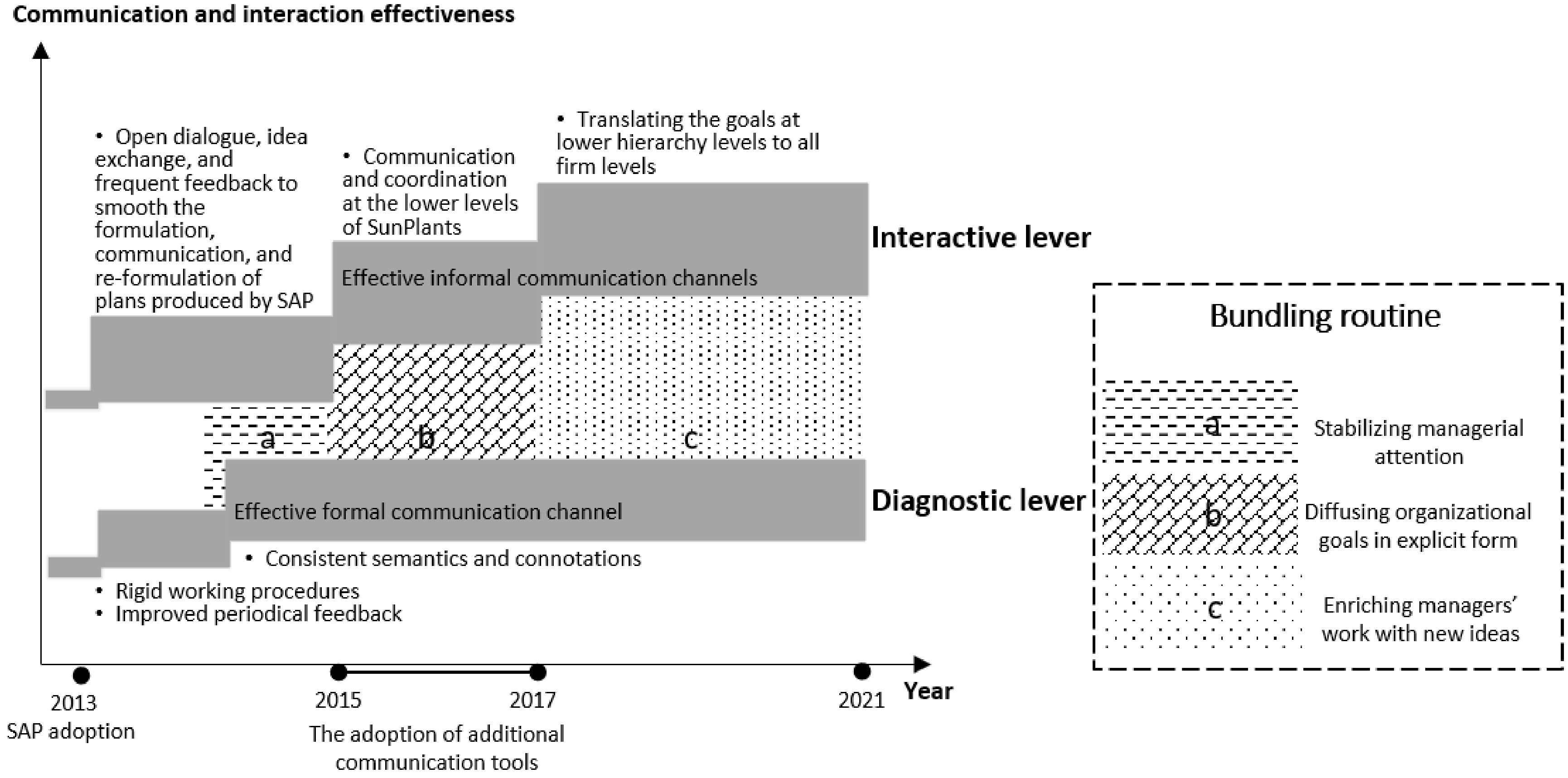

Diagram 11 Coordination and synchronization of Marketing, R&D, and Production Capabilities

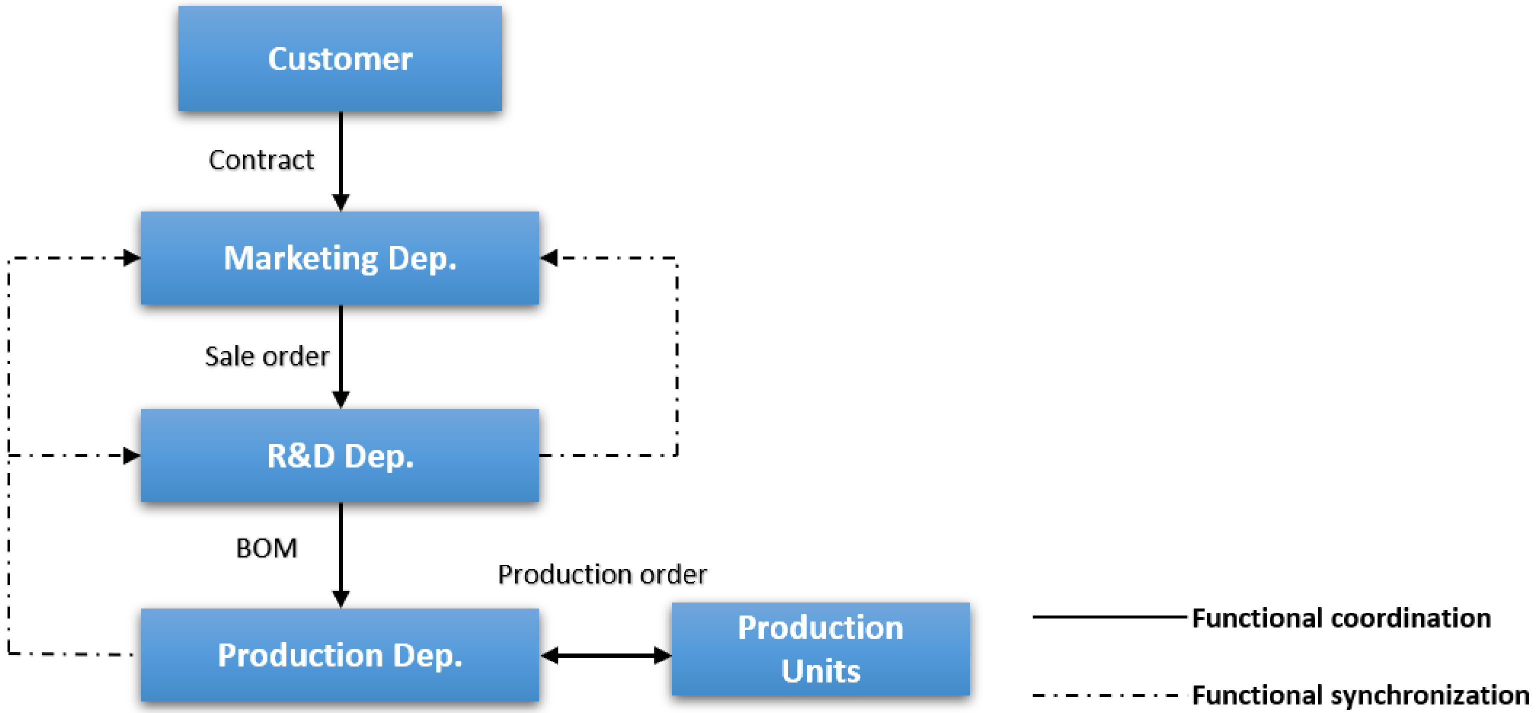

Table 14 The complementary relation of the control levers in the leveraging routine

<table>
<tr><th>The outcome of complementary use of levers</th><th>SAP-based diagnostic lever</th><th>SAP-based interactive lever</th></tr>
<tr><td>Dynamic coordination between the customer demands, products, and production</td><td>• SAP-based diagnostic lever provides a complete PLM mechanism for each specific product category;
• SAP-based diagnostic lever helps managers monitor nearly all the actions involved in the product lifecycle.</td><td>• SAP-based interactive lever facilitates the exchange of information in PLM and SAP;
• SAP-based interactive lever promotes frequent interactions between the actors of three core departments (e.g., marketing, production, and R&D departments).</td></tr>
<tr><td>Translating business into data</td><td rowspan="2">• SAP-based diagnostic lever involves the use of critical performance measures over actions across the R&D-production loop.</td><td rowspan="2">• SAP-based interactive lever motivates the gathering of information outside of routine channels;
• SAP-based interactive lever offers a framework to enable the senior management to produce non-standardized assessments;
• SAP-based interactive lever provides frameworks, or agendas, for discussion in support of decision-making and control.</td></tr>
<tr><td>Translating data into business</td></tr>
<tr><td>Reflective actors</td><td colspan="2">Both the diagnostic lever and interactive lever support:
• the reflective actors in continuing to incorporate both informal and formal communications for frequent feedback and interactions;
• the reflective actors in engaging in data and information maintenance and working procedure improvement;
• the reflective actors in building upon and modifying control levers through more intelligent information analytics;
• the reflective actors in engaging in progressive revision, modification, and change in MCS.</td></tr>
</table>

Table 15 Examples of planning, cybernetic controls, compensation and rewards, and administrative controls that were involved in the complementary use of the diagnostic and interactive levers

	Example of planning	Example of cybernetic controls	Example of compensation and rewards	Example of administrative controls
First stage	Sharing the capacities externally not only aims to produce an additional profit source but provides access to additional data and information so as to make the action patterns more adjustable under various conditions. SunPlants could make frequent and accurate (re)planning and semi-real time progress evaluations.	The progress monitoring function, which offers progress and performance information, carefully monitoring the movement of organizational resources	Subsequently, SAP merely enacts the old compensation system. Although SAP-based PMS have been technologically constructed, a proper modification in the compensation system corresponding to the “changed performance” is still absent.	In the production line, SunPlants’ is working two shifts a day, and most machines are assigned two workers operating one machine in a day. Each worker has to collect and report how the machine operated and worked during their shift.
Second stage	The interviewees demonstrate that planning was always time-consuming, bringing about coordination inefficiency, even when SAP was adopted.	In this way, periodical reports are produced for managers for decision-making and control.	———	SAP supports the formal set of MCS through communication channels based on rigid working procedures.
Third stage	In this way, SunPlants could synchronize information between these three departments. This synchronization supports effective sales order decoupling and consolidation (points). Based on these points, managers become more effective in deploying resources through maintaining production and operation integration and segmentation.	SunPlants adopts the PLM (product life cycle management) module in SAP. PLM enables the diagnostic lever to be configured for each specific product category. In this way, nearly all of the actions involved in the product life cycle are monitored.	———	Due to the “manufacturing to order” (MTO) production strategy, a particular production routine starts only after receiving a customer’s order. The marketing department translates a contract into a sales order to confirm customer requirements. The order is then sent to the R&D department for product design and BOM (bill of material) generation. The marketing department receives feedback mainly in the form of BOM via SAP from the R&D department and forwards it to the production department. The production department then generates the production order specifying the production quantities and dates and sends them to the production units via SAP.

Table 16 The shifting nature of the complementary relations

	Location of the complementary that occurred	Time of occurrence	Subjects	Objects	Technical features	Content of the complementary relations
First stage	The complementarity occurs: • within the internal of the diagnostic lever; • in the structuring routine.	The initial stage of the post upgrading of ERP	• Senior managers • Production staff • Production managers	• Effective enactment of the PMS to motivate better behavior of production staff	• SAP delivers precise and real-time performance monitoring data	• SAP materializes renewing the pay-for-performance relation • Senior managers enable the enactment of the renewed relation
Second stage	The complementarity occurs: • between the interactive and diagnostic levers; • in the bundling routine.	2-3 years after the ERP upgrade	• All the actors involved in marketing, R&D and production actions • Interactive team	• Frequent feedback and interaction among marketing, R&D, and production actors • Efficient decision-making and control throughout the product development process	• SAP constructs a formal communication channel across different functional areas • SAP can accommodate additional communications	• More data & information from other systems • Minor ideas were created
Third stage	The complementarity occurs: • between the interactive and diagnostic levers; • in the leveraging routine.	4 years after the ERP upgrade.	• SAP users • Senior managers • Reflective actors	• Mutual translation of business and data. • Synchronizing resources and actions • Reducing the decision latency	• SAP offers some specific ERP modules to construct superior communication and interaction loop across functions • SAP provides state-of-the-art logic that effectively monitors actions throughout the entire product lifecycle	• Translating and visualising business and transactions into figures and data • Effective utilization of performance measures, feedback loops and rigid work procedures in translation • Gathering information outside the routine channels • Building the R&D-production loop

Chapter 6. Conclusion

6.1 Introduction

This thesis investigates the relationship between ERP, MCS, and DC by focusing on the impact of the post-upgrading of ERP on MCS practices in a leading Chinese medium-sized manufacturer. This study shows how accounting can secure a core role in the organizational arena in the digitalization age, especially within China's rapid digitalization-based transformation.

The modern notions of ERP-based decision-making and control are traced and explored by focusing on the organizational and strategic domains concerning customer relationships, resource optimization, and NPD. To this end, this thesis sets three primary research objectives (sub-objectives): (1) to investigate the impact of the post-upgrading of ERP on CRM changes and discovers possible ways of using ERP-based MCS to develop three DC routines (i.e., sensing routine, seizing routine, and reconfiguring routine), (2) to investigate how the post-upgrading of ERP impacts MCS configurations and reconfigurations, and how the ERP-based MCS configurations and reconfigurations enable resource reconfiguration (RR), and (3) to explore how the post-upgrading of ERP leverages the sophisticated use of MCS in NPD practices and traces how the leveraging effect enables resource orchestration (RO).

These objectives are met by employing a single qualitative case study that sourced data from 67 interviews[115] and internal documents of the case company.[116] Adopting Feldman and Pentland's (2003) theory helps to meet the first research objective, Malmi and Brown's (2008) framework of studying MCS as a package helps to meet the second research objective, and Simons's (1994) theory of lever of control helps to meet the

[115] Interviews were conducted with the senior managers, middle managers, and employees of SunPlants and its software vendor's engineers.

[116] Internal documents are SAP project investigation documents, IT infrastructure reports, IPO prospectus, and organizational profiles and online source.

third research objective. Next, I constructed three self-contained empirical studies (Chapters 3 to 5), with a review of the relevant literature and a report of the empirical findings for each research objective.

The remaining parts of this chapter summarize the main findings, highlight the research contributions and practical implications, and indicate the limitations and future research opportunities.

6.2 Summary of main findings

This thesis produces several research findings by discussing ERP-based MCS issues in three main strategic capabilities in the case company: dynamic capability routines based on CRM actions, resource reconfiguration based on material resource-related actions, and resource orchestration based on production and R&D actions. The main findings are detailed as follows.

The first empirical chapter (Chapter 3) addresses the first research objective, which is to investigate the impact of the post-upgrading of ERP on CRM practice and changes and discover possible ways of using ERP-based MCS to develop three different dynamic capability routines. Drawing on the organizational routine theory, this chapter shows that the ERP-based MCS changes may appear as three ways of improvement at the micro-foundation level: first, the information connection at the artifact aspect; second, the action pattern abstraction at the ostensive aspect; and third, the bottom penetration at the performative aspect. ERP-based MCS changes appear as the incorporation of three terms: ostensive aspects, performative aspects, and various artifacts. The changes that occur at the micro-foundation level directly promote CRM practices to develop the seizing and reconfiguring routines but not the sensing routine. The changes also confirm the essential interdependencies between (digital) technologies and MCS (Dechow and Mouritsen 2005).

The second empirical chapter (Chapter 4) addresses the second research objective: to investigate how the post-upgrading of ERP impacts MCS configurations and reconfigurations, and how they enable resource reconfiguration in the context of material resource-related actions. Adopting the notion of studying MCS as a package, this chapter reveals that the ERP-based MCS changes that promote material resources-related actions lie within three configuration forms: the basic, intermediate, and advanced forms. The three forms describe how MCS techniques are configured and reconfigured to cope with different levels of complexities of resources and actions. Each form also produces varying levels of visibility, recognizability, and controllability of material resources and related actions, leading to different methods of resource reconfiguration.

Additionally, based on the three forms, this chapter recognizes the importance of the dynamic fit between structural rigidity and functional flexibility of ERP in maintaining effective MCS reconfiguration and control outcomes for reconfiguring resources. In this way, MCS can maintain and alter organizational action patterns to stabilize the company while preventing radical modification of existing principles in dynamic conditions.

The third empirical chapter (Chapter 5) addresses the third research objective, which is to explore how the post-upgrading of ERP leverages the sophisticated use of MCS in new product development practices, and traces how the leveraging effect enables resource orchestration for NPD. Guided by the levers of control theory, this chapter discovers that the ERP-based MCS changes manifest as a complementary relation. This means that MCS changes might not occur in isolation. Moreover, the complementary relationships are shifting (e.g., Latour 1996; Mundy 2010) across various strategic routines, timeframes, actors, and objectives involved in NPD and are associated with different technical features.

This shifting relationship is embodied as the different ERP-based complementary uses of diagnostic and interactive levers. Subsequently, MCS practices are used for structuring resource portfolios through monitoring resource movement and motivating actors' behavior, bundling resources into the NPD capability to meet rapidly customer needs, and leveraging the capability to be distinctive and sustainable through the mutual translation of business and data. Additionally, senior management involvement, the presence of the interactive team and reflective actors may determine the leveraging effect of the shifting complementary relation on resource orchestration.

In summary, through understanding the ERP-based MCS changes, the ERP-based MCS is characterized as playing a constructing role in different aspects of dynamic capabilities. ERP-based MCS may not merely be the instrument to construct dynamic capabilities but offers the source of power in both principle and practice and the means of carrying the power.

The impact of ERP-based MCS practices is far beyond operational efficiency improvements, however it has a core role in creating value through strategic actions generating sustainable rents. Besides, ERP-based MCS develops as a framework that enables managers to digitalize every aspect of the business strategy and organizational reality.

6.3 Research contributions

This thesis has demonstrated the generative process by which MCS changes are produced by ERP (Chapter 3), the forms of the ERP-based changes (Chapter 4), and relationships within the ERP-based MCS change (Chapter 5). The MCS changes are also analyzed in accordance with their impact on dynamic capabilities that lead to competitive advantages. Not only each of the empirical chapters makes a three-fold contribution, but also this thesis provides a broader set of insights and contributes to a broader set of debates in the extended literature in four ways. They are detailed as follows.

6.3.1 Specific contributions in each empirical chapter

The first empirical chapter (Chapter 3) makes the following contributions. First, it contributes to the MCS-ERP literature by revealing and tracing how the three major ERP upgrade-based MCS changes have been created (i.e., through enhanced information connection at the artifact aspect, action pattern abstraction at the ostensive aspect, and bottom penetration at the performative aspect). The impact of the post-upgrading of ERP on accounting practices has been recognized (Wagner *et al.* 2011), however, the existing MCS-ERP literature might have no opportunity to observe the post-upgrading of ERP. This chapter bridges this research gap by focusing on the post-upgrading of ERP.

The chapter also highlights that the ERP upgrade-based MCS changes may occur simultaneously at various levels (i.e., the ostensive aspect, performative aspect, and the artifacts aspect), instead of appearing at the level of information or physical systems (Dechow and Mouritsen 2005; Quattrone and Hopper 2005) in the initial ERP adoption. Knowledge about the three changes could suggest future MCS-ERP studies, especially those concerning the post-upgrading of ERP, focusing on how MCS changes occur simultaneously at various abstract and concrete levels.

Second, the three constructs developed in this chapter (i.e., accounting and operational artifacts, and common artifacts) might theoretically contribute to the organizational routine theory. These three concepts respond to recent calls to build connections between capabilities and organizational routine (e.g., Howard-Grenville and Rerup 2016; Parmigiani and Howard-Grenville 2011).

Accounting and operational artifacts represent specific artifacts that are produced in different operational (performative) areas. In this chapter, they are characterized as having different functions, posting/update times, and connections (i.e., widely connected, or isolated). Common artifacts show how specific artifacts are further connected, transformed, and maintained for effective decision-making and control practices in three core strategic routines (e.g., sensing, seizing, and reconfiguring routines). These three constructs suggest possible future organizational routine theory-based studies: accounting and operational artifacts could work together to promote and navigate the challenging process of creating and replicating new routines across multiple functional areas within a company.

Third, this chapter contributes to understanding the practical ways of developing DC by exploring how the impact of the post-upgrading of ERP on CRM and MCS differs in three different DC routines. Researchers have recognized the importance of studying the practical ways of developing DC to compete in increasingly dynamic environments (e.g., Ambrosini and Bowman 2009; Dixon *et al.* 2014; Salvato and Vassolo 2018; Zahra *et al.* 2006). I demonstrate how the specific benefits (e.g., the broader physical memory space for transaction recording) involved in the post-upgrading of ERP improve the concrete accounting practices (e.g., accounts receivable) of CRM in order to facilitate specific customer-related actions leading to different DC routines. This informs the senior managers, who may not have had satisfactory ERP experiences, to notice that ERP per se might not promote accounting practices. Accounting practices could therefore be promoted by ERP when specific ERP functions and modules are properly selected and implemented.

Furthermore, I reveal the critical role of the flexible use of other digital artifacts producing engineering data to facilitate ERP and MCS to the three DC routines. This knowledge suggests to those managers who wish to make the business-accounting integration (yè cái róng hé, 业财融合[117]) that this integration is not merely about merging data. It is also concerned with the use of physical-digital technologies to make extensive data collection, extraction and connection, and business process reduction.

The second empirical chapter (Chapter 4) makes three contributions. First, it empirically contributes to the MCS-ERP literature by providing initial evidence on the impact of structural rigidity and functional flexibility of ERP on enabling various MCS configuration forms. Such new evidence also implies that MCS and ERP that work together in dynamic conditions may be sensitive to the fit between structural rigidity and the functional flexibility of ERP. This evidence is important in order to update the MCS-ERP literature, because existing studies that are primarily based on relatively stable conditions do not reckon with the emergent IT infrastructure and MCS changes that serve to stabilize a company’s operation in dynamic conditions. The evidence could also suggest that future MCS-ERP studies embrace the multiple aspects (e.g., structural

[117] This term is popular in China’s accounting research arena, which could be basically understood as the integration of the management accounting tools and methods based on business processes.

vs. functional) of ERP and how each aspect affects MCS integration.

Second, this chapter contributes to Malmi and Brown's (2008) theoretical framework by clarifying how individual MCS techniques are configured and reconfigured. This incremental contribution is important because it theoretically contributes to the limited but essential understandings of how multiple MCS techniques are actually configured and reconfigured in a company (e.g., Bedford *et al.* 2016; Malmi and Brown 2008; Otley 2016; Sandelin 2008).

Not only does it confirm the existence of the combinative form of MCS techniques in the case company, but also it indicates that ERP might be critical in realizing the combinative form of MCS practices. Additionally, ERP-adopting companies might rely on the coexistence of multiple MCS configurations. This understanding could suggest that the future studies that are based on Malmi and Brown's (2008) framework consider, first, the multiple instead of the single MCS configurations and second, technology-in-use that might make the MCS configurations differ.

Third, identifying three MCS configuration forms offers practical insights into accounting digitalization as an area that challenges the current accounting practice (Bhimani and Willcocks 2014; Quattrone 2016). The three forms of MCS configurations allow us to capture how the MCS configuration is constructed in terms of visibility, recognizability, and controllability, and how the configuration varies across various levels of action dynamics and complexities. Such three forms broaden the scope of MCS practices by producing visibility by numbers and reporting, to offering decision alternatives using analytics via digitalized means.

The third empirical chapter (Chapter 5) makes three key contributions. First, this study extends the MCS-ERP literature by revealing the shifting complementary relations of ERP-based MCS changes. Existing ERP-based MCS literature does not focus on the complementary use of MCS to delve into ERP-based MCS practices (e.g., Kruis *et al.* 2016), but existing MCS-ERP literature is limited under either abstract MCS terms (e.g., Dechow and Mouritsen 2005; Malmi and Brown 2008) or specific MCS practices (e.g., Chapman and Kihn 2009; Wagner *et al.* 2011). The shifting complementarity relation is based on understanding the diagnostic and interactive levers but is not explicitly studied by prior LOC-based studies.

This contribution is essential to extend the MCS-ERP literature because the shifting complementarity relations explain how various actors (the subjects of the relation) work with ERP to engage in different but congruent decision-making and control practices. The shifting complementarity may suggest that future MCS-ERP literature consider more complex decision-making situations[118] in order to explore how ERP contributes to the concurrent multiple MCS changes.

Second, understanding the shifting nature of the complementarity relation might contribute to the LOC theory because it reveals more concrete and specific terms involved in the decision-making and control process. The terms indicate the different actors involved (e.g., the controlling actors and the controlled actors, interactive team, and reflective actors), the changing control objectives, and the varying timeframe of enacting MCS in establishing the complementarity of the diagnostic and interactive levers. Developing the understanding of LOC and the levers' complementarity is critical to know how to steer MCS-in-use so as to stabilize the operation or progressively change a company's strategy (e.g., Frow *et al.* 2010; Simons 1994; Tessier and Otley 2012).

While the majority of existing LOC studies have explored LOC in isolation (e.g., Abernethy and Brownell 1999; Bisbe and Otley 2004; Kober *et al.* 2007; Widener 2007), the shifting complementarity is consistent with, and may extend, recent studies that explore the combined impacts of pairs of levers (Mundy 2010; Tessier and Otley 2012). This understanding may suggest that future LOC-based studies investigate how multiple complementary relationships develop between a particular period in order to meet specific business strategies.

[118] That is, a setting where not only there is no obviously correct choice but also there are multiple answers that warrant further and more times of experimentation before committing to a single approach.

Finally, detailing SunPlants' experience of post-upgrading of ERP to promote production and R&D might also have some practical significance. Although the finding is not an ERP project guidance, it indicates those companies that will make the ERP upgrade in order to notice the potential risks of the intense use of formal communication channels. This chapter also characterizes the interactive team as the main force in the SAP-based complementary use of diagnostic and interactive levers and reflective actors as special ERP users, encouraging ERP-adopting companies to find them out from the ERP users. This suggests that senior managers of ERP-adopting companies identify their interactive team(s) and the reflective actors, in order to help the company to make progressive MCS changes leading to better organizational performance.

6.3.2 *Contributions to the extended management accounting literature that examines multiple management control practices simultaneously*

In addition to the specific contributions made in each empirical chapter, this thesis provides a broader set of insights and contributes to a broader set of debates in the extended literature and an increasing interest in management accounting research to examine multiple management control practices simultaneously.

First, this thesis confirms that Bedford's (2020) idea that one MC package is composed of one or more sets of interdependent practices because I observed four main MC practices that are developed as various functional sets involved in three MC configuration forms (i.e. MC packages). Also, this thesis confirms that the MC techniques of the MC package would vary in the number and strength of their interdependencies, as expected by, for example, Orton and Weick (1990). The confirmations might be important to inform future research that examines how MC practices work interdependently or simultaneously: this thesis has empirically verified that what is constituted and what is left out in one MC package vary over time. Future research is encouraged to focus on the changes of the MC package or changes between MC packages.

Second, this thesis empirically finds that making each MC practice composing the MC package be coordinated might be realistically difficult and not worth doing it, which might contribute to further understanding the constitution of the MC package. Existing literature has revealed how MC practices of one MC package work to maximize the control effectiveness in a given context. For example, Demartini and Otley (2020) consider that it is essential to maintain the MC package as a more loosely integrated set of mechanisms because it allows the simultaneous existence of rationality and indeterminacy, which would occur at any organizational level.[119] Indeed, a company needs to serve both efficiency and innovation objectives (Simons 1995). This thesis may contribute to the loosely integrated (or coupling) perspective of studying MC as a package by revealing why MC techniques are partly uncoordinated. MC techniques in one MC package may lack cooperative planning and organization—managers do not have sufficient thought for how the different MC techniques work together when the package is initially designed and configured. Meanwhile, actors could not coordinate their actions well at all the time following the principles, rules, standards, programs, and procedures inscribed by the MC practices—sometimes MC practices need to change to match actors' capability. The contributions might be important to inform future research that studies MC practice as package: the inner working of the MC package—how they combine and work in one way rather than other ways—is as complex as its constituents. On the other hand, future research is suggested to focus on the constituents and the inner working together because they might be mutually determined when building the MC package.

Third, this thesis provides insight into defining and specifying the control problem(s)—the critical issues of studying MC as a package—by exploring how control problems are bounded to the company's specific strategic capabilities other than the company's general strategic choices. Previous literature has shed light on the importance of defining and specifying control problems to understand how MC practices work

[119] Demartini and Otley (2020) explain that tight coupling makes coordinated adjustments more difficult, as changing one MC practice will affect other MC practices with potentially unintended consequences, whereas loose coupling allows for greater flexibility and local adaptation to contextual variations.

interdependently (Academy of management reviewHenri and Wouters 2020; Bedford 2020; e.g., Friis *et al.* 2015; Gerdin *et al.* 2019; Grabner and Moers 2013; Posch 2020; Speklé and Widener 2020). To join into the accomplishment of defining and specifying control problems, this thesis links the defining and specifying of control problems with specific strategies of a company. Existing empirical studies concerning MC as a package have considered strategy an important contextual factor, such as differentiation strategy (e.g., Academy of management reviewHenri and Wouters 2020; Posch 2020), and product innovation strategy (Malmi *et al.* 2020) because strategic issues (e.g., strategic uncertainties will affect the way control problems arise and be solved (Simons 1990, 1994). However, they employ general strategy concepts and categories, which might be incapable of explaining how control problems are related to specific organizational resources and capabilities or how MC practices work together to reach specific strategic goals. The contributions of this thesis provide new evidence for future research that studies MC practice as package: as long as the company's strategy is well-specified in terms of its resources and concreate capabilities, particular MC practices could be more appropriately combined and recombined to solve one or more control problems effectively. Future studies are suggested to consider more specific issues of strategic resources or capabilities rather general strategic stances or choice, when they define and specify the control problem during the inquiry of combinative MC practices.

Fourth, this thesis renews the perspective of studying MC as package by extending the depth of focus on exploring the way of combining MC practices and defining control problem(s). In particular, this thesis theorizes why and how the presence of management control practices could provide information to support particular organizational capabilities (e.g., resource reconfiguration and new product development). The extended depth of focus is theoretically important because management control systems are the 'formal, information-based routines and procedures managers use to maintain or alter patterns in organizational activities' (Simons, 1995, p. 5). This implies the core function of management control systems—providing managers with information for decision-making and control—are related to strategic implementation, operational resource allocation, or behavior directing, regardless of what the company's control problems are.

Given the importance of the informational aspect to combining MC practices, Academy of management reviewHenri and Wouters (2020) examine specific informational properties related to the management control practices, which are functionality and diversity. However, such two informational properties are merely concerned about the informational needs of the user and the variety of the organization's performance measures. On the other hand, what is equally important, the informational aspect is primarily intended to convey information, such as about one's competence or ability (e.g., Deci *et al.* 1981; Rosenfield *et al.* 1980; Schedlinsky *et al.* 2020).

Hence, this thesis reveals the importance of attending to the variability of the multitude of data dimensions when multiple MC practices are combined for solving particular control problem(s). The variability of the multitude of data dimensions seems important to understand management control practices in the digitalization age. Within the context of the digitalization age, data loaded into the information systems (e.g., ERP) for use in management control becomes increasingly variable because the multitude of data dimensions results from multiple disparate data types and sources.[120] Through the three empirical chapters, I reveal how MC practices work interdependently with the multitude of data dimensions, continuing the re-defining of control problems MC practices are supposed to address and the specifying of more specified strategic goals MC practices are supposed to ensure to achieve. Future research is informed to focus on the ongoing combination or recombination of MC techniques, the rebuilding of the multitude of data dimensions, and the re-defining of control problems in given contexts.

6.4 Limitations and avenues for future research

Although I have identified some contributions in each empirical chapter, the chapters are bound to some limitations. The first empirical chapter is based on the general

[120] For example, in the case of SunPlants, large multitute of engineering data and transaction data are generated during the day-to-day business, which are integraed in the use of MC practices.

concepts of the organizational routine, without specification of the routine components. For example, the ostensive aspect seems to differ from the abstract level to the less abstract level (e.g., formal accounting controls vs cultural controls). This chapter does not investigate the various dimensions of the artifacts because the focus is to produce a general picture of the relationship between routine and artifacts from an accounting perspective. On the other hand, artifacts have instrumental, aesthetic, and symbolic dimensions (Rafaeli and Vilnai-Yavetz 2004; Vilnai-Yavetz and Rafaeli 2006). Artifacts are at the center of organizational routine and play a key role in debates about materialism and agency (Pentland and Feldman 2008). Hence, future research is encouraged to explore the more specific aspects of routines and artifacts, which might help to show how MCS collaborates with new digital technologies or artifacts to improve routines and boost organizational performance.

Additionally, the first empirical chapter focuses on applying digital technologies in the management control over customer-related actions and CRM practices. These actions and practices are not as complicated as those specified in production and R&D processes; for example, in action planning (e.g., daily-based plans), real-time performance/variance feedback, or cybernetic controls (e.g., based on each day or even an order), compensation plans (e.g., based on individuals), and organizational structure (e.g., the integration of departments). Further studies are suggested to look into production or R&D contexts that may generate excellent outcomes concerning how a company can develop DC by digital technologies and MCS practices.

In the second empirical chapter, I do not observe the impact of ERP on rewards and incentive systems and cultural control[121] due to accessibility and ethical problems. Although Girod and Whittington (2017, p. 1123) claim that "reconfigurations do not entail widespread changes in reward or career structures," I suggest that not focusing on rewards and compensation and cultural controls would cause biases in the research outcomes. Future research is encouraged to develop methods to avoid ethical problems

[121] I was not allowed to access the data in relation to rewards and compensation systems.

to study the rewards and compensation, and cultural controls. Second, this chapter does not clarify how a set of MCS techniques or practices is selected to configure in ERP. This chapter's focus is the configuration and reconfiguration per se and their impacts on business strategy. Future research is encouraged to advance knowledge by focusing instead on selection issues.

Additionally, I encourage future research to enter into a broader context beyond actions related to material resources. Specifying a situation to see how ERP can (or cannot) work with MCS to produce visibility and controllability makes more specific impacts on organizational actions that require further investigation (e.g., operational level vs. strategic level, intradepartmental level vs. inter-department level, or single-activity vs. bundled activities).

The third empirical chapter is inherent with limitations due to methodological and theoretical restrictions. First, this chapter focuses on the two critical functions (i.e., production and R&D) that work together for RO. However, RO involves more than these two functions; for example, warehousing, procurement, marketing, and advertising are also parts of RO, but at the time of the interview, SunPlants' RO for NPD was merely characterized by the integration of production and R&D functions. More compelling methodological and theoretical frameworks could be considered and designed to integrate additional critical functions to produce a more comprehensive explanation and theorization of the use of MCS and ERP for RO.

Second, this chapter explores a particular NPD setting where product innovations are created and brought to the market for the first time by modifying and improving existing products. Broadly speaking, there are companies involved in two other NPD settings, including products that have never been designed or produced previously but have been taken to market for the first time by rivals with original product innovations. These two settings have distinct patterns by which to orchestrate resources and actions in NPD and production processes, and are associated with various ERP uses to leverage MCS. Future MCS-ERP studies are encouraged to embrace these two NPD settings to examine how ERP-based sophisticated MCS are used and what ERP-based MCS changes occur within them.

In addition, a relevant MCS change might not be about an empirical phenomenon, but an “epi-phenomenon” or a “non-phenomenon”: “It may be an illusion of the observer, a kind of ‘organizational mirage’” (Burns and Vaivio 2001, p. 393). Indeed, emerging data, information, and technologies change the way human actors perceive reality. Future studies are encouraged to capture the epiphenomenon or a non-phenomenon.

Given the above limitations, it may be more appropriate to view this thesis as preliminary empirical research regarding Chinese ERP-based MCS issues and a call for more in-depth investigations of the issue in the future. The limitations, in turn, may be addressed when Chinese ERP-based MCS or digitalization-based MCS is developed to a more mature level.

Final comments

According to Gartner, a global-leading consulting company, digitalization impacts the business model, providing new opportunities for value generation and broadening the business landscape. Hence, accounting is inevitable to be affected by digitalization (Möller *et al.* 2020).

The impacts of digitalization on business and accounting are extremely notable in China over recent years. From a management accounting perspective, this thesis contributes to understanding, analyzing, and evaluating the impacts of digitalization on business and accounting. This thesis then explores how digitalized management accounting creates a source of competitive advantages. This thesis finds that the interrelation of digitalization and management accounting goes beyond the supply of quality data and information and the provision of effective communications for decision-making and control. Instead, digitalization and management accounting work together to mobilize and materialize different strategy implementation and control approaches by improving data structure, reconfiguring resources, and orchestrating workflows.

In summary, this thesis demonstrates that the beneficiary companies of digitalization are most likely to be those operating in an increasingly competitive industry and market. Moreover, these companies are characterized as encountering enormous complexities in managing resources and actions and involving a strict new product development process. I believe that digitalization can stimulate tremendous development of management accounting to secure its central role in the organization and create a source of competitive advantage for the organization.

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