A process model of dynamic capability development: Evidence from the Chinese manufacturing sector

Abstract

Based on longitudinal case studies of manufacturing strategy and implementation at two Chinese manufacturing firms, this paper investigates how these firms develop, manage and deploy dynamic capabilities to renew their resource bases in order to respond to the operational challenges associated with radical technological development. Our analysis suggests that dynamic capability development is not simply about renewing one specific type of capability, but rather, it is a meta-capability to learn how to repeatedly renew the firm's overall capability set as a fully integrated package. We further highlight the importance of looking beyond the property of the firm to understand the network level of capability development, including the capabilities of the firm's partners. This is particularly salient in the context of smart manufacturing where a high level of connectivity among a broader network of partners is required to reap the benefits generated by new technological advances. Our findings provide an important contribution to our knowledge of dynamic capability development in emerging economies in the era of digitalized manufacturing.

Key words: Dynamic capability development, Emerging economies, China, Digital manufacturing

INTRODUCTION

Triggered by the internet, the astonishing rise in data volumes and cyber physical connectivity enables communication between humans as well as machines in cyber-physical internet-based systems to acquire and process data and to self-control certain tasks (Manyika et al., 2011). This technological shift is radically transforming the performance of manufacturing activities. Consequently, many countries with important manufacturing sectors are exploring ways to revolutionize and renew their existing manufacturing competencies. In this context, new manufacturing capabilities need to be established to enable firms to extend and renew their resource bases in order to respond effectively to rapid technological developments. Central to this view is an emphasis on dynamic capability development (e.g., Eisenhardt & Martin, 2000; Teece, Pisano, & Shuen, 1997; Williamson, 2016; Zollo, Bettinazzi, Neumann, & Snoeren, 2016). Broadly defined, dynamic capability is an organization's capacity to purposefully create, extend or modify its resource base to achieve sustainable advantages through adaptation to the changing shape of the external environment (Helfat et al., 2007; Teece, 2007; Teece et al., 1997).

Radical technological change often creates capability gaps for manufacturing firms because it introduces new ways of performing manufacturing activities, and new ways of creating value. This is particularly challenging for manufacturing firms from emerging economies accustomed to leveraging labor-intensive and low-specialist technological skills to manufacture simple products in order to serve low cost market segments (Aggarwal & Weekly, 1982; Malik & Kotabe, 2009; Wells, 1983). With historically low emphasis on R&D and consequently weak technological capabilities (Henderson & Cockburn, 2000; West & DeCastro, 2001), the processes of developing new capabilities for firms from emerging economies responding to radical technological change are quite distinct from R&D based on learning before doing (Henderson & Cockburn, 2000). The institutional characteristics of

emerging economies are also greatly different from those of industrialized economies (Meyer & Peng, 2005; Wright, Filatotchev, Hoskissen, & Peng, 2005). Therefore, an interesting question arises: how do manufacturing firms in emerging economies renew their existing resource bases in order to respond to radical technological developments?

We chose manufacturing firms in China to pursue our research question for three reasons. First, low resource cost has long been the key advantage for China's manufacturing industry. However, this advantage is being challenged with the development of digitalized manufacturing as a different set of capabilities are required to respond to radical industry change. Manufacturing firms in China's transformation from low cost to digitalized manufacturing processes therefore present unique problems and research opportunities. Second, as the world's largest manufacturing hub, China is exerting a growing impact on the global economy (Roach, 2003). Due to the size of its economy and the extent of its engagement in the global manufacturing sector (Peng & Luo, 2000), understanding how manufacturing companies in China are transforming to embrace new technology developments is a timely undertaking for both China and the world with which it increasingly engages. Third, China presents a distinctive institutional environment (Whetten, 2009), which requires the theoretical incorporation of specific socio-economic contexts, a theme highlighted by many scholars in the business and management field (Lewin, 2014; Whetten, 2009). This setting thus provides a useful context to explore our research questions.

Our study makes an important contribution to the dynamic capability literature by answering the call to identify capabilities that lead to superior performance in a specific context (Collis, 1994; Priem & Butler, 2001; Williamson, 2016). Drawing from longitudinal qualitative data, our findings illuminate a process model that not only shows how dynamic capabilities are formed and developed, but also sheds light on the specific mechanisms which interconnect different stages of their development in manufacturing firms in China. We argue that

dynamic capability development is not simply about renewing one specific type of capability, but rather, it is a meta-capability to learn how to repeatedly renew the firm's overall capability set as a fully integrated package. This is consistent with theoretical insights highlighting dynamic capability as a "higher order capability" or "meta-capability" that relates to learning to learn (Ambrosini & Bowman, 2009; Collis, 1994; Lewin, Massini, & Peeters, 2011; Teece, 2007, 2012).

This study therefore provides a holistic and more comprehensive understanding of the process by which manufacturing firms from emerging economies develop capabilities which enable them to thrive in a new industry era. By doing so, we make an important contribution to the existing literature on the micro-foundation of capabilities and their evolution over time in the context of a fast-changing and volatile environment (Ambrosini & Bowman, 2009; Teece, 2007; Teece et al., 1997). We further highlight the importance of looking beyond the perimeter (Zollo et al., 2016) of the firm to understand the network level of capability development, including the capabilities of the firm's partners. In this way, firms can simultaneously co-evolve with their partners to ensure the evolutionary fitness (e.g., Helfat et al., 2007) of increasingly co-specialized asset configurations (Siggelkow, 2002).

The remainder of this article is structured as follows. We first review the concept of dynamic capability and its application to emerging economies. We then set out the research design and method of this study. This is followed by a discussion of our findings where we distil the theoretical insights that emerge from this study and present some theoretical and practical implications. Finally, we identify the limitations of our study and suggest avenues for future research.

THEORETICAL BACKGROUND

The recent literature on dynamic capabilities in emerging economies provides some key concepts as a theoretical foundation for our research. Central to the origins of competitive advantage is the question of how the firm manages its resources to create more value than its rivals (Brandenburger & Stuart, 1996). Rooted in the early contribution of Penrose (1959), the resource-based view (RBV) postulates that possessing valuable, rare, inimitable and non-substitutable resources provides the basis for value creation (Barney, 1991; Wernerfelt, 1984). In this view, success is mainly attributable to superior resource endowment (Barney, 1991; Peteraf & Barney, 2003). With the increasing recognition that the current business environment is hypercompetitive (D'Aveni, 1994) and highly volatile (Eisenhardt, 1989b), the dynamic capability view (Teece et al., 1997) was introduced to complement the RBV by identifying the capabilities which help firms to successfully apply their resources across multiple environments and situations. While the RBV asserts that firms create superior economic return by being more effective than their rivals at possessing and selecting resources, the dynamic capability perspective asserts that firms generate economic rent by being more effective than their rivals at deploying and reconfiguring resources.

Often referred to as repetitive task-oriented actions involving multiple actors (Winter, 2003), dynamic capabilities are created by organizational learning (Eisenhardt & Martin, 2000) in a process of co-evolution of past experience, knowledge articulation and knowledge codification processes (Zollo & Winter, 2002). Teece (2012) further explicitly argues that dynamic capabilities cannot be reduced to routines, but are something above and beyond these. This view is shared by scholars who view dynamic capability as meta-capability (Ambrosini & Bowman, 2009; Lewin et al., 2011) where "the capability that wins tomorrow is the capability to develop the capability to develop capability that innovates faster (or better), and so on" (Collis, 1994: 148). It has been claimed that the development of such capabilities is constrained by the firm's existing base of capabilities, and is shaped by its

current market position and path dependent history of developing capabilities (Teece et al., 1997). The notion of orchestration has been introduced to describe capability development in the context of the extended enterprise (Helfat et al., 2007; Teece, 2007). For example, Teece (2007) proposed the concept of co-specialization where the value of an asset is a function of its use in conjunction with other assets. Capturing co-specialization benefits frequently requires integrating operations, and an organization's ability to identify, develop and leverage specialized and co-specialized assets, built or bought, is a core dynamic capability (Augier & Teece, 2007).

A small but growing stream of enquiry in the literature focuses on dynamic capability development and deployment in emerging economies. Compared to firms in advanced countries, firms from emerging economies often face unique challenges in developing their capabilities due to resource scarcities and ideology-based institutional imprinting (Kriauciunas & Kale, 2006; Malik & Kotabe, 2009). Due to lack of availability of domestically produced capital equipment and technologies (Tybout, 2000), these firms typically produce less advanced products (Aggarwal & Weekly, 1982) to serve low cost market segments (Wells, 1983). Most manufacturing firms therefore rely heavily on equipment and technologies imported from industrialized countries (Tybout, 2000). Given this lack of technological and product focused R&D capabilities (West & DeCastro, 2001), a specific set of capabilities to integrate externally sourced technologies with firm-level routines is required to upgrade the firm's performance.

Following this observation, there have been numerous studies of the capability development of firms from emerging economies. These include investigations of Russian oil companies (e.g., Dixon & Day, 2010; Dixon, Meyer, & Day, 2014), Indian and Pakistani manufacturing firms (e.g., Malik & Kotabe, 2009), the Indian pharmaceutical industry (e.g., Athreye, Kale, & Ramani, 2009; Kale, 2010), a South Korean motor company (e.g., Kim, 1997), a diverse

set of innovative Chinese companies (Williamson, 2016) and the Taiwanese semi-conductor industry (e.g., Mathews & Cho, 2000). For example, Dixon and Day (2010) and Dixon, Meyer and Day (2014) identified two distinctive types of dynamic capability: adaptation and innovation, which helped to achieve both short-term and long-term competitive advantages in the context of a Russian Oil Company. Malik and Kotabe (2009) identified three dynamic capability development mechanisms, namely organizational learning, reverse engineering and manufacturing flexibilities, which had significant impact on firm performance in India and Pakistan. Williamson (2016) indicated that creating flexible organizational structures and processes is key for Chinese firms to build and leverage dynamic capability.

At the outset, capability development is also constrained by the institutional environment in which firms are embedded in (Meyer & Peng, 2005). Many scholars have highlighted that the institutional context of emerging economies is significantly different from that of industrialized economies (Wright et al., 2005) because each have highly distinctive resource pools and highly distinctive game rules (Li, 1994; 2010). As the most singular of the emerging economies, China presents a distinctive institutional environment (Whetten, 2009; Peng & Luo, 2000). Until recently, the Chinese manufacturing sector has leveraged competitive advantage in the global market from the country's vast population and relatively low wage rates. However, the advantages associated with these resources and assets are being challenged in the context of digitalized manufacturing (Magnier, 2016). As the primary driving force of economic reform (Peng & Luo, 2000), the Chinese government has proposed a new plan "Made in China 2025", which aims to build an intelligent, digitalized and networked Chinese manufacturing sector (Bland, 2015). This transition has created a novel "non-market" environment for those manufacturing firms that have low technological and specialist skills and have been heavily relying on cheap labor and imported technologies to manufacture their products.

Taken together, the unique institutional characteristics in China, coupled with radical technology changes, lead to firm-level changes in resources and capabilities that are different from those in industrialized economies. Despite the significant effort invested by the academic community to create dynamic capability theory, "we have limited understanding of where capabilities come from or what kinds of investment in money, time and managerial effort is required in building them" (Ethiraj, Kale, Jrishanan, & Singh, 2005: 25). Encouraged by recent calls to develop and test theory pertaining to firms from emerging economies (Meyer, 2015; Tsui, 2006; 2007; Whetten, 2009; Wright et al., 2005), we address our research question by building upon the theory of dynamic capability to specifically explore how manufacturing firms in China purposefully develop, manage and deploy capabilities to renew their resource bases in order to respond to the technological challenge.

METHOD

Given the relatively new and unexplored nature of the phenomenon, we pursued an induction-driven research design that is suitable for generating theory about novel phenomena (Locke, 2001). Consistent with the evolutionary and interpretive nature of our analysis (Maitlis, 2005; Weick, 1993), we conducted a longitudinal field study (Yin, 2014) using two innovative Chinese manufacturing companies as our primary source of empirical evidence. This approach allowed us to obtain a fine-grained appreciation of the processes that contribute to dynamic capability development over an extended period of time.

Sample selection

We adopted a theoretical sampling method (Eisenhardt, 1989a; Miles & Huberman, 1994) and selected cases based on several criteria that helped to illuminate the processes we were seeking to describe. First, we compiled a list of Chinese manufacturing firms that are actively engaged in "smart manufacturing" practices and therefore provide an opportunity to

investigate how firms develop manufacturing capabilities that assist them to embrace the development of new technologies. Second, following the suggestions provided by Block and MacMillan (1985) and Yin (2014), two similar companies were chosen from the initial sample of 7 that were closely matched with regards to their starting conditions and stages of new venture developments. This enabled us to control the differences in terms of the (1) timing of entry, (2) availability of resources, and (3) new venture development as factors associated with competitive advantage (Lieberman & Montgomery, 1988). The selected manufacturing sectors are textiles and electronic goods, and we call our two case companies Tie and Sho. We ensured that our case firms were quite similar in their capability to reallocate their resources in response to radical technological change as this parallel process tracing is an integral part of most similar case analysis (Tarrow, 2010). Table 1 provides an overview of the firms. Choosing case firms that were relatively similar in many aspects had several advantages: firstly, it made possible a deeper investigation of their capability development paths (Laamanen & Wallin, 2009; Langley, 1999); secondly, it enabled emerging conceptual insights from one case to be confirmed or disconfirmed by comparative evidence from the other case (Yin, 2014); and thirdly, it allowed us to control for potential confounding of the relationships of theoretical interest (Nielsen, 2016). Due to the sensitive nature and depth of the information sought, accessibility also influenced the selection of specific firms.

INSERT TABLE 1 ABOUT HERE

Data Collection

Research access was negotiated through a personal contact who introduced two researchers to the selected companies in April, 2009. We considered this approach appropriate and necessary in the context of China, as informants may not be willing to share information with

unfamiliar interviewers (Hwang, 1987; Tsang, 1998). Two rounds of interviews were carried out in order to collect the primary evidence, the first being in July-September 2009. At that stage, semi-structured interviews were arranged with top and middle management as well as lower-echelon employees at the case sites. The main benefit of selecting informants from different hierarchical levels was to ensure exposure to different perspectives, to compensate for individual informants' personal bias and lack of knowledge, and to allow cross-checking of information provided by different informants (Huber & Power, 1985). Interviews typically lasted 90 to 150 minutes. In total 36 interviews were conducted.

All interviews were conducted in Chinese. The interview protocol began with general questions about the informants and their perceptions of current trends in the industry. Informants were then asked about how the changes in China affected the ability of their firms to reconfigure their resource bases. This was followed by question sets which invited informants to explain how and why decisions were made and actions undertaken to extend or reconfigure their firms' existing resource bases, and how any resulting conflicts were resolved. Further questions probing for specific details were asked in subsequent interviews, and these were based on information shared by participants during our initial interviews. This approach allowed us to investigate emerging themes and to return to specific topics for clarification. The interviews were tape recorded (with 6 exceptions) and transcribed verbatim within a week of the interviews. In keeping with Eisenhardt and Graebner's (2007) recommendation to bolster the credibility of the data, a "courtroom questioning" technique was used, where informants were encouraged to provide concrete examples to support their commentary about actions taken in the development of their firms' capabilities. Complete anonymity was promised in order to encourage the participants to give candid responses.

The second round of semi-structured interviews was carried out in April-June, 2014. In order to track our firms' capability development processes, we conducted 21 additional interviews

designed to further probe the underlying reasoning behind the different stages of their evolution. This phase enriched our understanding of the context within which the changes took place and allowed us to gather information on specific areas of each organization, such as product design and digital systems, which had not been fully established in the first round of interviews. Table 2 summarizes the distribution of interviews. This approach enabled the collection of both real-time and retrospective data, thus providing better grounding for theorization and mitigating any effects of retrospective bias (Leonard-Barton, 1990).

INSERT TABLE 2 ABOUT HERE

To assure the accuracy of the interview data, we conducted member checks (Lincoln & Guba, 1985) in which the original informants verified our interview transcripts or notes. The interview data were supplemented by secondary data in the form of archived material from each company, such as minutes of meetings, internal correspondence and memos, trade magazines and relevant media publications. This approach allowed us to triangulate the data to mitigate possible informant and other biases, and to supplement personal accounts with rich and detailed contextual evidence (Jick, 1979).

Data Analysis

Consistent with common prescriptions for longitudinal case studies (Langley, 1999; Yin, 2014), we first wrote individual case histories (Brown & Eisenhardt, 1997) using data gathered from both interview transcripts and archival material, in particular, of the period covering the digital transformation. We endeavored to create a "chain of evidence" that allows others to "follow the derivation of any evidence from initial research questions to ultimate case study conclusions" (Yin, 2014:127). A key step in the analysis was to create an event listing to provide insight into "what led to what, and when" (Miles & Huberman, 1994: 110), depicting the sequences in which capabilities were developed. We then identified

specific actions and decisions that were associated with changes in the resources deployed, and the configuration of activities at different phases of organizational change. To avoid errors arising from halo effects and interpretation biases (Strauss & Corbin, 1998), we followed an iterative process of noting quotes and concepts on note cards, symmetrically arranging these cards into themes and concepts, and reviewing our notes to identify patterns and themes across interviews. We then compared across cases to construct a conceptual framework (Eisenhardt, 1989a). This action enabled us to compare the cases to identify common dilemmas and refine the unique aspects of each particular case.

Our regular contacts with both companies allowed us to deepen our understanding of specific issues with additional background information and put our findings into perspective. We also used discussions of our emergent frameworks with colleagues as well as key informants as further validity checks for our emerging interpretations. This procedure continued until it was possible to explain the processes that had been observed, and further data collection provided no new insights into dynamic capability development (Glaser & Strauss, 1967). The entire analysis was highly iterative and involved moving back and forth among the chronology of events, our interview data, the existing literature and the constructs that emerged as salient at the research site. In table 3, we summarize the process of theory development through the different stages of analysing the data.

INSERT TABLE 3 ABOUT HERE

RESULTS

From these rich data, a detailed pattern emerged of how two manufacturing firms in China renew, modify and extend their existing resource base to respond to technological change. This is captured by a model with three phases: establishing a new focus of attention; focusing

on resource transformation; and co-evolution with the ecosystem. In this section, we follow best practices for qualitative research and rely on a detailed account of our observations to support our emergent conceptual framework (Eisenhardt & Graebner, 2007). In figure 1, we have provided a timeline of the emergence and evolution of key actions in the transformation process. We intersperse the narratives with significant quotes intended to illustrate our interpretation, and we display additional selected quotes in tables 4-6 to illustrate and document the robustness of our claims. We will next present the processes of dynamic capability development manifested at the different phases of the firm's transformation.

INSERT FIGURE 1 ABOUT HERE

Phase 1: Establishing a New Focus of Attention

The starting point for our model begins as the firm establishes a new strategic direction. Both firms changed their focus of attention between 2006 and 2007 after protracted discussions about the potential opportunities and threats information technology could bring to traditional manufacturing firms. Despite being able to realize rent from their existing resources and capabilities, both firms began to question the extent to which the resources associated with their existing competitive advantages would be relevant in the future. For example, an internal memo circulated by Tie April 2006 stated: "We are entering the winter season for manufacturing firms. If we stick with traditional Original Design Manufacture (ODM) or Original Equipment Manufacture (OEM), we will have no future". Meetings with top management committees were organized to discuss the visions and actions required to support the new changes. We noted consistent patterns of capability development during this phase of each company's change of strategic direction: unlearning from past experience; investing in new resource base development; and building a collective learning culture. Additional selected quotes are presented in table 4.

INSERT TABLE 4 ABOUT HERE

Unlearning from past experience and history

For both firms, the most important issue at the beginning was to re-evaluate existing strategy and envisage possible changes deemed necessary for the new strategic direction. We found that both firms displayed a distinct pattern in how they drove the unlearning process to embrace change. Information gathered from secondary data such as internal correspondence and minutes of meetings confirmed this pattern. While this was a straightforward process for Sho following the arrival of a new leadership team, Tie experienced great difficulties in convincing their top management to change. In early 2006, a small number of board members started questioning Tie's existing strategy and developed a new vision. However, this vision was widely criticized by other senior managers, as reflected in the following observations:

"We had many senior managers in their 50s and 60s on the executive board. They know the tricks of the trade, well, for the old game. I remember when I first proposed the ideas at the executive meeting, everybody was highly sceptical and one of them pulled me to one side after the meeting and said to me: *"don't ruin your father's business""*. (Tie, 004a).

In the case of Sho, the newly restructured leadership team was keen to drive the changes in Summer 2007. Informants from Sho described how the new management team "created a rather bold vision" and *"moved away from what they knew in the past".* The concept of unlearning was constantly brought up by our informants as an essential step to move forward. One informant observed:

*"*We have relied on cheap resources such as labor and materials for a very long time. So the whole discussion around digital and smart manufacturing sounds rather alien to us. We need to empty what is in our minds about what worked in the past and think from a new *perspective"*. (Sho, 002a).

Our evidence suggests then that when changes are radical rather than incremental, the direct re-use of routines and processes originating from firms' path dependent histories and experience will be restricted because actions precipitated by such routines reflect the business logic of the environment for which they were conceived. This is particularly evident in the Chinese context where the manufacture of textiles and electronic products was previously labor intensive and where routines developed in a prior environment are no longer fit for the new digitalized manufacturing processes.

Investing in new resource bases

Between 2007 and 2010, we noted that both firms had invested significantly in infrastructure and talent development at an early stage of digital transformation. New capabilities were required not only in IT related domains, but also in R&D, managerial talent and the skilled employees. Although both firms were able to import advanced technologies and equipment from industrialized economies such as Germany, recruiting skilled employees was more challenging. This was highlighted constantly throughout our interview. For example, one informant commented:

"There isn't much talent available as most of the workforce has only the 9 years' compulsory education in China and nothing more. That was okay in the past, but not for the future. We need people with higher and relevant skills to manage and work with the machines. Factory work in China has long been associated with low social status, so not many graduates are *willing to work in factories"*. (Tie, 005a).

Archival records such as minutes of meetings and informants' comments highlighted the challenge to both firms due to the lack of people with managerial skills. Indeed, digitalized manufacturing requires in-depth understanding of digital processes, systems and data, so developing internal managerial knowledge and skills becomes even more critical at a time

when such skills are sparse in the labor market. However, according to informants, the industrial workforce is rather weak in China. Consequently, both firms invested significantly in re-training the existing workforce from 2007-2010 to keep pace with the introduction of new technologies. The investment in human elements was repeatedly highlighted throughout the interview. This kind of investment was referred as "soft investment", and was seen as equally, or even more, important than "hard investment" (technology, equipment), as explained in the following comment:

"We also invested quite heavily in developing talent from the inside of the organization. We sent some of our managers to Germany to work on projects along with experienced managers to develop tacit managerial knowledge*"*. (Sho, 002a).

Many informants remarked that for firms that previously focused on leveraging cheap resources to achieve competitive advantage, investment in upgrading resources such as technology and employee skills was crucial to catch up with manufacturing firms in Europe or North America. The extent of this investment in building and acquiring new tangible and intangible resource bases was confirmed by archival data.

Building a collective learning culture

Whilst emphasizing the importance of integrating the new digital strategy throughout the company, both firms pointed out the importance of building a collective learning culture to drive people's desire for change. Both primary and secondary data point to the actions that were taken to stimulate a collective learning culture. Although information technology was adopted in the early 2000s to improve manufacturing efficiency in both firms, comprehensive digital strategies required a different mind-set to go beyond existing digital capabilities. Recognizing the potential impact of the new digital trends on manufacturing activities

required creativity and imagination. One member of the senior leadership team from Tie commented:

"It is not all about the technology. It*'s* also about changes in our mind-set, the business model, the regulations and even our environment. All of the changes require new knowledge. You need everybody to become like a sponge to soak up new knowledge. Without new knowledge, how do you know what an*d how to change?"* (Tie, 001a).

To initiate transformative changes, attention was paid particularly to building an emotional connection among the firm's employees. Rather than pushing for changes, both firms developed a compelling vision of what the future organization should look like. This vision drove a new, dynamic, learning culture which encouraged employees to reflect on the potential changes and impact of the transformation to digitalized manufacturing. This is reflected by the following observation:

"We can drive production efficiency by telling them exactly what to do, but we can't force them to think differently and creatively. We provided many learning opportunities to stimulate that kind of interaction both within and outside of the firm. Rather than making it compulsory, we wanted people to get excited about the ideas, about the future, and this acted as a *stimulus to get them to learn"*. (Sho, 004a).

This view was confirmed by the lower-echelon employees. According to one employee: "There were many rumours that we were going to lose our jobs and be replaced by machines. It was a surprise to us all that so many training development opportunities were created for us. What was even more surprising was that they [senior management] told us that having a degree doesn't really matter, that what matters is our desire to learn*"*. (Sho, 007a).

Phase 2: Focusing On Resource Transformation

In phase 2, both firms focused on translating their new strategic focus into tangible action in order to embrace technology development from 2008 to 2013. As smart manufacturing requires a different type of interaction between people and machines, with significant implications for organizational structures, routines and processes, both firms engaged in a set of activities to renew and transform their resources. To execute the changes, we noted that in phase 2, the focus shifted over time from one capability to another: the capability to experiment; the capability to divest; and the capability to build extended networks. Additional selected quotes are presented in table 5.

INSERT TABLE 5 ABOUT HERE

Experimentation

From our data it is clear that both firms were making small changes and experimenting with new processes and routines after building up tangible and intangible resources. While Tie spent many years experimenting with new ways of producing tailored garments at mass production price, Sho was trying out a highly automated plant that would enable full visibility of operations, remote monitoring and control, and real time optimization through new technologies. Informants reported how the emphasis gradually shifted from being mainly centred on productivity and efficiency to experimentation and innovation. For example, one informant commented:

*"M*easuring and patterning are the most important and most expensive part of tailored production. It took us a while to come up with *'coordinate measurement'*, where you only need to locate three points of reference to collect 22 measurements. It is a trial and error *process"*. (Tie, 007b).

Similarly, informants from Sho indicated how experimental learning took place by using a virtual plant and products to simulate physical production so that every process is first simulated and verified virtually before being introduced and implemented at the physical factory level. This evidence was supported by the archival data which documented the process of experimentation, from virtual simulation to initial trial and final implementation.

In addition, our informants brought our attention to the ways their firms were experimenting with management styles. After introducing a different operating system which connected all the equipment to generate a significant amount of data, the previous hierarchical management system became obsolete. Therefore, a new way was required to manage the more dispersed data and control the new production process. As one informant put it:

*"*It is no longer about command and control. When you have a manufacturing floor where smart machines can make decisions, you need to have people to monitor them, to fix the problems there and then. We had to apply new management skills to support the changes that were taking place on the factory floor*"*. (Sho, 010a).

Divesting the existing resource base

There was a consistent pattern in the informants' perceptions regarding the necessity of divesting firm-controlled resources. The new ways of integrating information technology required a major cognitive re-orientation. We noted that after unlearning their path dependent histories, experiences and routines, both firms re-evaluated their existing resources and made the decision to shed resources that would no longer contribute to their new digitalized manufacturing strategy. Both firms needed to divest less-value-adding resources to generate the slack and flexibility needed to acquire or accumulate resources of higher value. This

capability was highlighted across several interviews, and is illustrated by the following comment:

"You need to completely break it down and see which one is relevant, which one you can leverage from your previous investment. That was the difficult part- letting go. When the *reform started, we were still heavily leveraging on our previous resources because we didn't* want to waste anything. This led us on a zigzag path, but you need to be decisive and start *shedding"*. (Tie, 005b).

Selecting the appropriate resources to divest was challenging for both firms. Both archival and interview data indicated that it was a lengthy process for both firms to decide which resources they could leverage successfully, and which ones they could divest without harming their existing competitive advantage. One member from Sho's senior management team pointed out:

*"*There were many uncertainties. We made mistakes because we couldn't accurately price exactly what was needed and what needed be got rid of. You need to know what is upgradable, to what extent, how that will change the process, and *in what time frame"*. (Sho, 004b).

Building extended networks

We noted that the term "network" was constantly repeated throughout our interviews during phase two. According to one informant, new operational processes require vertical integration connecting different parts of the supply chain to drive value through transparency and process automation. This operational requirement compelled both firms to address the changes along with their supply chain partners. While both firms were able to initiate and implement

changes within the firm, they encountered challenges in dealing with the impact of disruptive technology on their existing supply chain partners, as reflected in the following comment:

"We had suppliers who were reluctant to make changes. It was extremely difficult to get everybody on board. They needed to change, and that meant at some point they had to invest quite heavily in upgrading their facilities and processes in order to integrate disparate *sources of data from different applications. You can't* simply move by yourself. You have to get the whole supply network to come with you*". (Tie, 011b)*.

In addition to the supply-side of their network, many informants identified a number of external factors pushing their companies to engage with a broader network of actors. These included: underdeveloped internet bandwidth and enterprise connections; fast growing data and software companies; and a low-skilled labour force. These institutional conditions served as stimuli for both firms to co-develop with their external partners. This marks a clear departure from the firm's reliance on previous supply-side networks towards a broader network system. For instance, the founder of Tie commented:

*"*We have to try to leverage with the whole spectrum of our network partners. For example, we look for support from policy makers for funding and technology support; universities and training agencies for high-skilled employees; network providers for a better internet *bandwidth; partners from different sectors to help us develop our new "networked" way of thinking; and our customers to get new ideas".* (Sho, 009b).

Phase 3: Co-evolution with the Ecosystem

In this phase, both firms systematically and continuously explored the possibilities of further manufacturing capability development within their extended networks, and began to renew their resource base accordingly. When we re-entered the organizations in 2014, the

transformation process had already entered what several informants later described as the "ecosystem game". The management teams from both firms exhibited an ongoing concern for market volatility and fierce competition. Three capability developments were particularly evident at this stage: the capability to institutionalize flexible routines; the capability to enrich their resource base; and the capability to coordinate extended networks. Additional selected quotes are presented in table 6.

INSERT TABLE 6 ABOUT HERE

Institutionalizing flexible routines

Informants from both firms made it abundantly clear that since time to market and customer responsiveness are key drivers for competitive advantage, it was of paramount importance for them to build a flexible manufacturing process. The flexibility of their new manufacturing processes was evidenced by the design of production lines both within the firm and across their networked partners, which resulted in: the ability to generate added value from individualized customization; a more dynamic allocation of resources; and reduced production complexity with fewer constraints. In both firms, the ability to build modular blocks to enable operation agility to respond to network partners as well as the market was crucial in ensuring competitive advantage. This view is exemplified by the following observation:

"We spent a great deal of time and effort trying to build standardized but flexible routines to respond to individual customers. We now have many small unit processes that are like Chinese lego, where you can change the configuration without interrupting the whole *process".* (Tie, 006b).

A similar observation was made at Sho, which has a highly automated plant. New routines and processes were designed to allow flexible and application-based reconfigurations of the production system. In addition to building flexible processes to ensure modular reconfiguration, many informants emphasized the importance of building a flexible workforce to facilitate the change. No longer focusing on a particular set of skills, workers also need to be equipped with IT competencies and knowledge related to a specific job or process such as techniques to work with and monitor robots. Senior management teams from both companies highlighted that apart from the hard knowledge and skills, the workforce will also have to possess greater flexibility to adapt to new roles and work environments, and get accustomed to continual interdisciplinary learning. This was represented in the following description:

"The flexible process needs to be driven by a flexible workforce. We need staff that know how to work with the machines, understand the data and know how to respond to the data in real time. They need to take responsibility to make d*ecisions". (Sho, 002b)*.

Enriching the firm's resources

The goal of resource enrichment is to extend and elaborate the firm's resources and capabilities in order to keep skills up to date. Our evidence revealed that in both cases, resource enrichment can be found in the form of learning new skills and technology, investing in additional resources that add value to the firm's existing resource portfolio, and co-opting resources available outside the organization. During this phase, both firms made substantial investment in hardware and software to further update their manufacturing capabilities. This was reflected by one informant as follows:

"We recently invested quite heavily to improve our data analytical skills to minimize the time we have to spend identifying the correlation between our 3d body-scanning database and the 2d *textile material database".* (Tie, 004b).

In addition to updating equipment and human resources, both firms simultaneously collaborated with external partners to co-opt critical technical expertise as well as infrastructure elements. One senior leader from Sho had this to say about his understanding of resource enrichment:

"You have to find different ways to augment your assets. Most companies rely on themselves and overlook the huge potential the outside world can bring. We design our products through virtual simulation software, which allows open source input to spur and improve our designs. Working with our partners, we put our data together and think about different business *models and patterns to drive more value out of it".* (Sho, 005b).

Coordinating extended networks

According to our informants, as their firms build extended networks, their capability to coordinate beyond the parameters of the firm becomes of paramount importance. Moving from a traditional to a digitalized model requires firms to move beyond the traditional boundaries of functions, production sites and companies. As the operational processes become more complex due to the increased integration of different technical disciplines and organizations, the firm's ability to manage different forms of cooperation between different partners is crucial. This is reflected by the following observation:

"Because everything is networked, you have to have this open mindset about how you can connect all the partners to maximize the value of your network. It is not an easy job. We are talking about increased integration, increased functionality, increased dynamic operations

requirement, increased real-time control, and not just your own control. You have to know how to work with your external partners, how to manage a complex web of connections*"*. (Tie, 001b).

According to our informants, instead of focusing on individual capabilities, firms need to develop their collective capability system as a whole, including their partners' capabilities. The terms "win-win", "reciprocal" and "interdependent" were frequently mentioned throughout our interviews, emphasizing the necessity for firms to coordinate their processes with their network partners. This coordination process contributes to the firm's ability to offer unique and innovative value to its customers. As one of the senior managers at Sho indicated:

*"We need to reposition ourselves as a platform that can connect w*ith different partners. To do so, we need the right digital infrastructure and interpersonal skills to interact with our network partners. I am not just talking about our direct supply chain partners. The concept of Industry 4.0 is only just beginning to emerge and we want to work with a broader network of partners to make sense of it together*". (Sho, 011b)*.

Interconnecting Mechanisms

In the previous section, we reported evidence to support a three-phase process model of capability development. In the following section, we investigate the causal and sequencing relationships between the phases to find out e.g. whether successful completion of the first phases of capability development automatically led our firms to phase 2, or whether progression depended on some other factors. Next we present our findings relating to these mechanisms.

Leadership competencies

The consistent pattern to emerge over two cases was that transitions from phase 1 to phase 2 required leaders to possess a particular set of skills. These skills are: 1) the ability to strategically plan the firm's workforce and 2) the ability to build an interdisciplinary system.

1. ability to strategically plan the *firm's workforce*

We noted that after the aspiration stage where our firms set new strategic goals, both leadership teams paid great attention to "new workforce planning" in order to be able to execute their new strategies. As the factory floors became networked, an increasing number of self-regulating systems and intelligent control mechanisms were challenging the conventional workforce distribution. Informants repeatedly highlighted that although many training and development opportunities were provided to re-skill the workforce, how to place them to drive the change was a key challenge facing both firms' top management. When asked to describe the key barriers to the actual execution, one informant from Sho commented:

"*It's definitely the mind*-set of how we view our employees, the work environment, the process and the content. On the smart manufacturing floor, the role of our employees and the work content change dramatically. The digitalized or smart manufacturing process requires real-time control and you need to know how to plan your workforce and trust them by giving them greater responsibility*"*. (Sho, 007b).

We found many of the secondary sources such as meeting notes confirmed this dilemma. A lot of discussion among the senior management teams was centred on the workforce planning analysis to get an insight into the necessary actions. Having a clear understanding of the new workforce dimension of smart manufacturing was perceived as a prerequisite condition for resource transformation.

2. ability to build an interdisciplinary system

In addition to strategic workforce planning, we also found a notable pattern between the two cases in their leadership's attention to building an interdisciplinary system. Senior management informants pointed out that as the physical flows (the flow of material components through the supply chain) are inextricably integrated with their information flow thanks to intelligent connectivity, firms need new forms of interdisciplinary thinking. The implication of this change is that mechanical engineering should also be inseparable from information technology, and different functions of operations processes, such as product design, production and logistics, need to be integrated to form new ways of creating value. The senior director from Tie, for example, viewed this competency as key to connecting the aspiration stage to the implementation stage.

*"The system need*s to be T-shaped and interdisciplinary rather than specialized. No operation unit can function alone. There has to be complete integration of equipment and process management. Physical things become part of the process and everything at the plant, the machine and process flow, becomes one single entity. In order to make this happen, an *interdisciplinary system including the machine and our workforce needs to be established".* (Tie, 006b).

Platform Competencies

According to our informants, as firms gradually move towards phase 3, the organization has to build a platform that connects different network partners to drive value creation for its customers. The level of focus therefore goes beyond firm-level analysis to the network-level of analysis. In order to make the successful transition from phase 2 to phase 3, the firm's platform competency is therefore paramount. Within this competency, two specific abilities

were highlighted during our interviews: 1) ability to build a digital platform infrastructure; 2) ability to motivate platform participation.

1. ability to build a digital platform infrastructure

At phase 3, the firm no longer focuses on internal and supply-side operational developments. As smart manufacturing drives full transparency, the firm must extend beyond the limits of an individual factory to interconnect multiple players within its extended network. However, both firms highlighted that a lack of interoperability posed great challenges for full integration. The key condition to solving this problem, according to our informants, is to build a "functional, user-friendly and compatible" digital platform infrastructure to enable collaboration. As one informant commented:

"You need a 'technology enabler' to do the job, which means that you need to design an architecture, I would prefer to call it *a "platform"*, that is stable enough to keep everything networked together. Without this intra-firm IT infrastructure, you are unable to unlock the full p*otential of digital manufacturing".* (Sho, 007b).

Our informants pointed out that this architecture needs to include shared services and applications to enable collaborative processes. A range of issues including data security, reliability, operator model convergence, real-time analysis and forecasting all need to be resolved for successful platform collaboration to happen. As one Tie informant commented:

"Availability of an efficient network infrastructure with high internet bandwidths is key to guaranteeing digital collaboration. Our system is progressing because the broadband internet infrastructure for the industrial level is being developed *in China". (Tie, 011b)*.

2. ability to motivate platform participation

Another key prerequisite condition for firms to move from phase 2 to phase 3 is the firm's ability to motivate and stimulate external partners to participate in unlocking further value creation opportunities. This is illustrated by the following quote:

"There is huge potential for our manufacturing development to turn *"dumb" product*ion into *"smart" product*ion, to turn mass standardization into mass customization, to bypass all the intermediaries and connect directly with customers, the list is long. But this potential can only be unlocked if you are able to encourage your partners to work together. Without their contribution or participation, your network is going to be *an "empty" network".* (Tie, 002b).

We observed that both firms were actively engaged in interacting with their network partners. It was highlighted by the top management teams from both firms that the tipping point is reached when the manufacturing firm starts to provide significant and sustainable value to the broader ecosystem. For example, one informant commented:

"The key point to build an ecosystem is to evaluate what your influence points are and how your influence points matter to others. So it is about identifying how and why you matter to others businesses, how you can offer an integrated *service as a whole".* (Sho, 010b).

DISCUSSION

In this section, we present an inductively-derived process model (Figure 2) that not only shows how capabilities are formed and developed to support digital transformation, but also sheds light on the specific mechanisms to interconnect different stages of the manufacturing firm's capability development.

INSERT FIGURE 2 ABOUT HERE

Although many scholars in the field of strategic management agree that dynamic capabilities contribute to the firm's competitive advantage, empirical investigations of the specific process by which manufacturing firms from emerging economies transform and renew their resources to respond to radical technological change are scarce. Furthermore, the extant studies in the strategic management discipline tend to focus on the correlation between manufacturing capability and the firm's competitive advantages, and on the attributes of manufacturing capabilities. Consequently, although we know that a number of manufacturing capabilities such as manufacturing flexibility and supplier integration represent key competitive advantages, the formation and development of these capabilities remain insufficiently understood. This study is significant in that it represents one of the first in-depth studies of how the dynamic capabilities of Chinese manufacturing firms are developed over time.

We also contribute to existing theory by demonstrating how certain capabilities are manifested at different stages of the firm's development. Some of the capabilities we highlight, such as unlearning, building a collective learning culture and institutionalizing flexible routines, share resemblances with capabilities noted in other industries in emerging economies, e.g. removal of rigidities (Kale, 2010); organizational learning (Malik & Kotabe, 2009); adaptation and innovation (Dixon et al, 2014). However, we disagree with the assumption that dynamic capability development is a path-dependent process (Helfat & Peteraf, 2003; Teece et al., 1997). Contrary to this assumption, our study shows that when faced with disruptive change, the firm's ability to unlearn from past experience and routine is essential to address the need for organizational change. The concept of unlearning has long been associated with the firm's ability to create and apply new knowledge and new knowledge structures (Bettis & Prahalad, 1995; Cepeda-Carrion, Navarro, & Martinez-Caro, 2012; Day, 1994). As Cepeda-Carrion et al. (2012) observe, unlearning is not only a

mechanism to forget or discard old knowledge, but is also the way in which companies are able to develop and make room for new knowledge. This capability is closely associated with the firm's capability to sense and shape opportunities and threats in the environment (Dixon & Day, 2010; Dixon, Meyer, & Day, 2014; Teece, 2007). Based on our data, unlearning-to-learn is an overarching theme of our three-phase process model, manifested by unlearning, divesting and enriching the firm's resources. Consistent with this view, our study shows that in the context of Chinese manufacturing firms which previously relied heavily on cheap labor and low technological capabilities to produce relatively simple products, unlearning was necessary to deal with the rigidities created by organizational path dependence. These findings are supportive of earlier assertions that breaking with the past and removing rigidities are key to developing new capabilities for firms from emerging economies (Dixon et al., 2010; Kale, 2010).

We also contribute to existing theory by highlighting the importance of collaboratively networked organizations and the value of co-creation in the era of digitalized industry. Our findings indicate that as production processes are interconnected and value creation is no longer restricted to firm-level activities, manufacturing firms need to compete collectively with their network partners against the networks of other companies. At this level, firms have to orchestrate co-specialized capabilities that can be sourced externally to ensure the evolutionary fitness (Helfat, et al., 2007) of increasingly co-specialized asset configurations (Siggelkow, 2002; Teece, 2007). We noted that in order to achieve maximum benefit from radical technological development, our two Chinese manufacturing firms developed coalitions with a broad range of partners including suppliers, customers, data providers, government agencies and even universities (See Table 5). This echoed Dixon and her colleagues' research (Dixon & Day, 2010; Dixon, Meyer, & Day, 2014), which found that lack of capability to co-evolve with its institutional environment contributed greatly to the

failure of the Russian Oil company Yukos. However, despite increasing interest in the topic, there does not appear to be much discussion of dynamic capability development on a system-wide basis. In this study we explicitly highlight the dynamics of value co-creation, and therefore support the view that system-wide investigations are required to understand how dynamic capabilities are developed and deployed (Pitelis & Teece, 2010).

Our findings also shed light on the interconnecting mechanisms that contribute to the process of manufacturing firms' dynamic capability development. Based on our data, we have proposed two interconnecting mechanisms which contribute to dynamic capability theory by explaining the linkages at different stages of the transformation process. Our analysis indicates that dynamic capabilities are emergent and evolving, and that their precise manifestations depend on the stage of the organization's development. Following our chain of evidence, we found that the focus and resourcing of capability development shift over time as firms evolve due to limited organizational attention (Ocasio, 1997). Therefore, we propose that dynamic capability development is not simply about renewing one specific type of capability, but rather, it is a meta-capability to learn how to repeatedly renew the firm's overall capability set as a fully integrated package. This is consistent with the concept of "meta-capability" (Ambrosini & Bowman, 2009; Collis, 1994, p148; Lewin et al., 2011).

This study also offers some insights for practitioners. As we are writing this paper, a large number of Chinese firms are in the process of transformation to digitalized manufacturing. This research provides some insights into the process of dynamic capability development which can be of some benefit to firms and managers considering this transformation. Managers need to be aware of the importance of unlearning knowledge which was conceived according to previously accepted business logics. Additionally, our firms' ability to invest in developing their resource bases was crucial due to the shortage of R&D and skilled

technological and managerial labor in the local environment. Our results also highlighted that in addition to harnessing their resource potential from within, firms should seek broader potential value creation opportunities with external partners. By being part of an ecosystem, a firm can have more flexibility to drive its innovation capabilities and to leverage its partners' resources to gain a sharper competitive edge. Both cases offer informative concepts and behaviour patterns that managers can use to make deeper and richer assessments of the ways in which they manage their firms' internal and external resources to create more sustainable value.

CONCLUSION

The process model presented here was derived from data from two specific manufacturing firms in China. However, no claim is made that the capabilities presented in this paper are exhaustive since the extent to which the processes and capabilities described in this research apply to other contexts can only be ascertained through further testing and investigation. In addition, this investigation focused on China, where market imperfections and scarcity of resources are particularly pressing. Whether our findings are replicable in other cultural settings or are unique to Chinese contexts is an empirical question, which further research might investigate either using similar in-depth case study designs as ours or using quantitative methods. Findings from such studies could then be used to expand or test our model on other industries from different countries.

Furthermore, due to the novelty of the digitalization of manufacturing, this research raises a number of interesting and fertile paths for future research to explore new theoretical frameworks and test extant theories of operations management in new contexts. Research could also address questions such as: how compatible this colossal sharing across databases is with the absorptive capacity of today's business organizations; and finally, how

manufacturing firms develop the capabilities required to stimulate ecosystem collaborations. We also consider that future research should specifically investigate manufacturing firms in other emerging economies in order to evaluate whether the findings in this study can be replicated there. By providing a new theoretical framework grounded in qualitative evidence from two Chinese companies, this research provides an important contribution to our knowledge of the development of dynamic capability in emerging economies in the era of digitalized manufacturing.

NOTES

1. The authors would like to thank their anonymous reviewers for their patience and extremely helpful hints over several revisions of this paper, particularly for one of the reviewers' suggestion on framing of the notion of dynamic capability as a meta-capability.

REFERENCES

Aggarwal, R., & Weekly, J. K. 1982. Foreign operations of third world multinationals: a literature review and analysis of Indian companies. **The Journal of Developing Areas,** 17: 13–30.

Ambrosini, V., & Bowman. C. 2009. What are dynamic capabilities and are they a useful construct in strategic management? **International Journal of Management Reviews**, 11(1), 29-49.

Athreye, S., Kale, D., & Ramani, S. V. 2009. Experimentation with strategy and the evolution of dynamic capability in the Indian pharmaceutical sector. **Industrial and Corporate Change**, 18(4): 729-759.

Augier, M., & Teece, D. J. 2007. Dynamic capabilities and multinational enterprise: Penrosean insights and omission. **Management International Review**, 47: 175-192.

Barney, J. B. 1991. Firm resources and sustained competitive advantage. **Journal of Management**, 17(1): 99-120.

Bettis, R. A., & Prahalad, C. K. 1995. The dominant logic: Retrospective and extension. **Strategic Management Journal**, 16: 5–14.

Bland, B. 2015. China manufacturing: Adapt or die. **Financial Times**. [Cited 17 June 2016.] Available from URL: http://www.ft.com/cms/s/0/95152528-789e-11e5-933d-efcdc3c11c89.html#axzz4A9KHfJ3o.

Block, Z., & MacMillan, I. C. 1985. Milestones for successful venture planning. **Harvard Business Review**, 63(5): 184-196.

Brandenburger, A. M., & Stuart, H.W. 1996. Value based strategy. **Journal of Economics and Management Strategy,** 5(1): 5-24.

Brown, S., & Eisenhardt, K. 1997. The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting organizations. **Administrative Science Quarterly,** 42: 1-34.

Cepeda-Carrion, G., Navarro, J.G.C., & Martinez-Caro, E. 2012. Improving the absorptive capacity through unlearning context: an empirical investigation in hospital-in-the-home units. **Service Industries Journal**, 32(9): 1551-1570.

Collis, D. J. 1994. Research note: how valuable are organizational capabilities? **Strategic Management Journal**, 15 (Winter Special Issue): 143-152.

D'Aveni, R. 1994. **Hypercompetition.** New York: Free Press.

Day, G.S. 1994. The Capabilities of market-driven organizations, **Journal of Change Management**, 10(3): 275-292.

Dixon, S. E. A., & Day, M. 2010. The rise and fall of Yukos: A Case Study of Success and Failure in an Unstable Institutional Environment. **Journal of Change Management**, 10(3): 275-292.

Dixon, S. E.A., Meyer, K, E., & Day, M. 2014. Building dynamic capabilities of adaptation and Innovation: A Study of Micro-Foundations. **Long Range Planning** 47 (4): 186-205.

Eisenhardt, K. M. 1989a. Building theory from case research. **Academy of Management Review,** 14: 532– 550.

Eisenhardt, K. M. 1989b. Making fast strategic decisions in high velocity environments, **Academy of Management Journal**, 32(3): 543–576.

Eisenhardt, K. M., & Graebner, M. E. 2007. Theory building from cases: opportunities and challenges. **Academy of Management Journal**, 50(1): 25–32.

Eisenhardt, K.M., & Martin, J.A. 2000. Dynamic capabilities: what are they? **Strategic Management Journal**, 21(10-11): 1105-1121.

Ethiraj, S. K., Kale, P., Jrishnan, M.S., & Singh, J.V. 2005. Where do capabilities come from and how do they matter? A study in the software service industry. **Strategic Management Journal**, 26(1): 25-45.

Glaser, B. G., & Strauss, A. L. 1967. **The Discovery of Grounded Theory: Strategies for Qualitative Research**. Hawthorne, NY: Aldine

Helfat, C. E., Finkelstein, S., Mitchell, W., Peteraf, M., Singh, H., Teece, D., & Winter, S. G. 2007. **Dynamic Capabilities: Understanding Strategic Change in Organizations**. Malden, MA: Blackwell.

Helfat, C. E., & Peteraf, M. A. 2003. The dynamic resource-based view: Capability lifecycles. **Strategic management journal**, 24(10): 997-1010.

Henderson, R., & Cockburn, I. 2000. Measuring competence? Exploring firm effects in drug discovery'. In G. Dosi, R. Nelson, & S. Winter (Eds), **The Nature and Dynamics of Organizational Capabilities**: 155–182. Oxford: Oxford University Press.

Huber, G.P., & Power, D.J. 1985. Retrospective reports of strategic level managers: guidelines for increasing their accuracy. **Strategic Management Journal**. 6: 171-180.

Hwang, K. K. 1987. Face and favor: The Chinese power game. **American Journal of Sociology,** 92: 944–974.

Jick, T. D. 1979. Mixing qualitative and quantitative methods: Triangulation in action. **Administrative Science Quarterly**, 24: 602–611.

Kale, D. 2010. The distinctive patterns of dynamic Learning and inter-firm differences in the Indian pharmaceutical industry. **British Journal of Management,** 21(1): 223-238.

Kim, L. 1997. ***Imitation to innovation: The dynamics of Korea's technological learning.*** Boston, MA: Harvard Business School Press.

Kriauciunas, A., & Kale, P. 2006. The impact of socialist imprinting and search of resource change: A study of firms in Lithuania. **Strategic Management Journal**, 27(7): 659–679.

Laamanen, T & Wallin, J. 2009. Cognitive dynamics of capability development paths. **Journal of Management Studies**, 46(6): 950-981.

Langley, A. 1999. Strategies for theorizing from process data. **Academy of Management Review,** 24(4): 691-710.

Leonard-Barton, D. 1990. A dual methodology for case studies: Synergistic use of a longitudinal single site with replicated multiple sites, **Organization Science**, 1(3): 248-265.

Lewin, A. 2014. Emerging economies open unlimited opportunities for advancing management and organization scholarship. **Management and Organization Review,** 10(1): 1–5.

Lewin, A. Y., Massini, S., & Peeters, C. 2011. Microfoundations of internal and external absorptive capacity routines. **Organization Science,** 22(1): 81-98.

Li, P. P. 1994. Strategy profiles of indigenous MNEs from the NIEs: the case of South Korea and Taiwan. **The International Executives**, 36(2): 147–170.

Li, P. P. 2010. Toward a learning-based view of internationalization: The accelerated trajectories of cross-border learning for latecomers. **Journal of International Management**, 16(1): 43–59.

Lieberman, M. B., & Montgomery, D. B. 1988. First mover advantages. **Strategic Management Journal,** 9(S1): 41-58.

Lincoln, Y. S., & Guba, E. G. 1985. **Naturalistic inquiry** (Vol. 75). Thousand Oaks, CA: Sage.

Locke, K. 2001. **Grounded theory in management research**. Thousand Oaks, CA: Sage.

Magnier, M. 2016. China Manufacturing Gauge Weakens Further as Economy Loses Steam. **The Wall Street Journal**. [Cited 16 June 2016.] Available from URL: http://www.wsj.com/articles/china-manufacturing-gauge-weakens-further-as-economy-loses-steam-1462248735.

Maitlis, S. 2005. The social processes of organizational sense making. **Academy of Management Journal,** 48(1): 21–49.

Malik, O. M., & Kotabe, M. 2009. Dynamic capabilities, government policies, and performance in firms from emerging economies: Evidence from India and Pakistan. **Journal of Management Studies,** 46(3): 421-450.

Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., & Byers, A. H. 2011. **Big Data: The Next Frontier for Innovation, Competition, and Productivity**. Lexington, KY: McKinsey & Company.

Mathews, J., & Cho, D.S. 2000. **Tiger Technology: The Creation of a Semiconductor Industry in East Asia**. Cambridge: Cambridge University Press.

Meyer, K.E. 2015. Context in management research in emerging economies. **Management and Organization Review,** 11(3): 369-377.

Meyer, K. E, & Peng, M. W. 2005. Probing theoretically into Central and Eastern Europe: transactions, resources, and institutions. **Journal of International Business Studies,** 36(6): 600-621.

Miles, M. B., & Huberman, A. M. 1994. **Qualitative data analysis: An expanded sourcebook.** Thousand Oaks, CA: Sage.

Nielsen, R. A. 2016. Case selection via matching. **Social Methods & Research**. 45(3): 569-597.

Ocasio, W. 1997. Towards an attention-based view of the firm. **Strategic Management Journal,** 18 (Summer Special Issue): 187–206.

Peng, M. W., & Luo, Y. 2000. Managerial ties and firm performance in a transition economy: the nature of a micro-macro link. **Academy of Management Journal**, 43(3): 486-501.

Penrose, E. T. 1959. **The Theory of the Growth of the Firm.** New York: John Wiley.

Peteraf, M., & Barney, J. 2003. Unravelling the resource based tangle. **Managerial and Decision Economics**, 24: 309-323.

Pitelis, C. N., & Teece, D. J. 2010. Cross-border market co-creation, dynamic capabilities and the entrepreneurial theory of the multinational enterprise. **Industrial and Corporate Change,** 19(4): 1247-1270.

Priem, R. L., & Butler, J. E. 2001. Is the resource-based 'view' a useful perspective for strategic management research? **Academy of Management Review**, 26 (1): 22-40.

Roach, S. 2003. China's Global Stature. **MorganStanley Global Economic Forum, May 21, 2003**. New York: MorganStanley.

Siggelkow, N. 2002. Evolution toward fit. **Administrative Science Quarterly**, 47(1): 125-159.

Strauss, A., & Corbin, J. 1998. **Basics of qualitative research: techniques and procedures for developing grounded theory**. Thousand Oaks, CA: Sage.

Tarrow, S. 2010. The strategy of paired comparison: Toward a theory of practice. **Comparative Political Studies**, 43(2): 230-259.

Teece, D. J. 2007. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. **Strategic Management Journal**, 28(13): 1319–1350.

Teece D. J. 2012. Dynamic capabilities: Routines versus entrepreneurial action. **Journal of Management Studies**, 49(8): 1395-1401.

Teece, D. J., Pisano, G., & Shuen, A. 1997. Dynamic capabilities and strategic management. **Strategic Management Journal**, 18(7): 509-533.

Tsang, E. W. K. 1998. Inside story: Mind your identity when conducting cross national research. **Organization Studies,** 19(3): 511–515.

Tsui, A. S. 2007. From homogenization to pluralism: International management research in the academy and beyond. **Academy of Management Journal**, 50(6):1353–1364.

Tsui, A. S. 2006. Contextualization in Chinese management research. **Management and Organization Review**, 2(1):1-13.

Tybout, J. 2000. Manufacturing firms in developing countries: how well do they do, and why? **Journal of Economic Literature**, 38(1): 11–44.

Weick, K. E. 1993. The collapse of sense making in organizations: The Mann Gulch disaster. **Administrative Science Quarterly,** 38(4): 628–652.

Wells, L. 1983. **Third World Multinationals: The Rise of Foreign Investment from Developing Countries**. Cambridge, MA: MIT Press.

Wernerfelt, B. 1984. A resource-based view of the firm, **Strategic Management Journal**, 5(2): 171-180.

West III, G., & DeCastro, J. 2001. The Achilles heel of firm strategy: Resource weaknesses and distinctive inadequacies. **Journal of Management Studies**, 38(3): 417–442.

Whetten, D. A. 2009. An examination of the interface between context and theory applied to the study of Chinese organizations. **Management and Organization Review,** 5(1): 29–55.

Williamson, P. J. 2016. Building and Leveraging Dynamic Capabilities: Insights from Accelerated Innovation in China. **Global Strategy Journal**, 6(3): 197-210.

Winter, S.G. 2003. Understanding dynamic capabilities. **Strategic Management Journal,** 24(10): 991-995.

Wright, M., Filatotchev, I., Hoskisson, R. E., & Peng, M. W. 2005. Strategy research in emerging economies: challenging the conventional wisdom. **Journal of Management Studies,** 42(1): 1-33.

Yin, R. K. 2014. **Case study research: Design and methods** (5th ed.). Thousand Oaks,

CA: Sage.

Zollo, M., & Winter, S.G. 2002. Deliberate learning and the evolution of dynamic capabilities, **Organization Science**, 13(3): 339-351.

Zollo, M., Bettinazzi, E.L.M., Neumann, K., & Snoeren, P. 2016. Toward a comprehensive model of organizational evolution: dynamic capabilities for innovation and adaptation of the enterprise model. **Global Strategy Journal**, 6(3): 225-244.

Table 1 Background Characteristics and Data Sources for Cases

Company name	Tie	Sho
Background characteristics	Company Tie previously focused on manufacturing standard suits. Went through an organization change and currently produces highly customized products at scale and affordable cost to address the trend toward mass personalization by leveraging big data and cloud computing technology.	Company Sho has been manufacturing electronic goods since its inception. Transformed and built a plant that allows full visibility of plant operations, remote monitoring and control and real time optimization through technologies such as internet of things, machine to machine communication and 3d printing.
Sector	Textile	Electronic
Year of establishment	1995	1996
Number of employees (approximately)	5,000	6,000
Semi-structured interviews • Tracking the process of digital transformation and firms' dynamic capability development during the process	31	26
Archival sources • Reconstruct the history of the organization • Triangulate informants' recollections • Help track external responses and coverage to organizational actions • Triangulation of informants' claims about the events and culture of the organization	Press articles Internal correspondence and memos Minutes of meetings Company newsletters Company reports	Press articles Internal correspondence and memos Minutes of meetings Company newsletters Company reports

Table 2 Breakdown of interviews by Company, Hierarchical level, and Period

	Tie		**Sho**	
Hierarchical level	Period 1 (a) (July-September 2009)	Period 2 (b) (April-June, 2014)	Period 1 (a) (July-September 2009)	Period 2 (b) (April-June, 2014)
Top management	4	3	4	2
	1 CEO/Co-Founder 1 Chief Operations Manager 2 Senior Purchasing Directors	1 CEO/Co-Founder 1 Deputy Chief Operations Manager 1 Senior Purchasing Director	1 CEO/Founder 2 Senior Operation Directors 1 Senior Supply Chain Manager	1 CEO/Founder 1 Deputy Operations Director
Middle management	8	5	6	4
	2 Business Development Managers 1 Human Resource Manager 2 Information System Managers 2 Factory Floor Supervisors 1 Supplier Relationship Manager	1 Business Development Manager 1 Information system Manager 1 Factory Floor Supervisor 1 Product Design Manager 1 Supplier relationship Manager	1 Purchasing Manager 1 R&D Manager 2 Engineer Managers 1 Team Director 1 Supply Network Manager	1 Engineer Manager 1 R&D Manager 1 Supply Network Manager 1 E-system Supervisor
lower-echelon employees	5	6	4	5
	3 Factory Floor Employees 2 Supplier Network Assistants	4 Factory Floor Employees (2) 1 Supplier Network Assistant 1 Product Design Assistant	3 Factory Floor Employees 1 Purchasing Assistant	3 Factory Floor Employees (1) 1 Purchasing Assistant 1 Engineer Assistant
Total	17	14	14	11

Notes

- Positions in italics are the same people that were involved in the first stage of data collection.
- Quotation code cited in the paper will be as follows (Company name, interview number and period).

Table 3 Stages in theory development

Analytical goal for stage	**Raw data used**	**Analytical procedure and its outcome**	**Implication for new theory development**
Describing the patterns of digital transformation in the focal companies.	Interviews, company newsletters and reports, and featured articles.	Thematic analysis. Producing a timeline of evolution of the firms.	Radical yet comprehensive transformation.
Specifying the capability development actions associated with each transformation stage.	Case histories, interviews, company newsletters and reports.	Break down the broad capability categories and reconceptualize the data; sequential coding of types of capability development actions into a timeline according to capability categories.	Types of capability development would seem to change depending on what is needed at different stages of firms' digital transformation.
Uncovering interconnecting mechanisms that drive the sequences of capability development.	Interviews, internal correspondence and memos, minutes of meetings.	Coding of transition mechanisms that drive the sequence of the firms' transformation, leading to different capability developments.	Dynamic capability is not simply renewing a specific type of capability but a meta-capability to learn to repeatedly renew the firm's overall capability set as a fully integrated package.
Developing an overall theoretical framework.	Interviews, case histories and data linked to new constructs.	Revision of the earlier framework, connect new construct to overall context to produce theoretical framework.	The level of dynamic capability development gradually evolves from firm level to network level.

Table 4 Phase 1-Establishing a new focus of attention: core capabilities and illustrative quotes

Core capability	Illustrative quotes
Unlearning from past experience and history	*"There were so m*any competitors in the Dongguan region doing the same thing. Some of the senior managers were comfortable doing what they had been doing for years but I knew something needed to be done. Letting the past go is the most painful part of the process. If you don't tip your old thoughts away and make space for new ideas, you will never be *able to make the move"*. (Sho, 008a) *"We were granted* many awards and nominated as the best enterprise in our regions, so we got loads of contracts. Many people find it difficult to understand why we wanted to change when we were that successful. As the CEO of the company, I know such success can cook you in a slow heat if you don't make a *move to change. It's like the frog story. We co*uld milk our success at least for the next 3-5 years, then what? We need to disrupt ourselves before someone else disrupts us, or before the environment disrupts *us". (Tie, 002a)* *"The discussion then about the technology was very exciting and the potential changes it will have on the whole industry is h*uge. The most important thing is that you need to look beyond what you have now, and think from a completely new angle to think how you can do things differently*". (Tie, 005a)*
Investing in new resource bases	*"There is a big gap between us and companies from Germany and Japan in terms of software development, key technology and pate*nt development, R&D development and skilled employees. We had to invest significantly to attract and develop new talents and buy some *equipment and technologies to make a start". (Sho, 004a)* *"When you talk about the technology, our IT infrastructure was far from ready to make the tra*nsition. Nobody (in China) cared about that kind of technology before. Good enough technology and equipment can do the job. Back then, we wanted an ERP (Enterprise Resource Planning) system that could support mass customization, but no firms, not even in Germany, had established such a system. So we had to develop it *ourselves. Lots of money has been spent on building this system." (Tie, 006a)* *"We are talking about a completely different game here. We didn't have* the necessary talent and skilled employees to do the job, neither did we have the technology or infrastructure that were needed. If you are serious about change, you have to get your wallet out and spend to upgrade *everything you have". (Sho, 013a)*
Building a collective learning culture	*"We were worried that we* would lose our jobs. There was a lot of speculation about how robots were going to replace us. Why do we need you if we can have robots doing jobs 24/7? We were surprised to see how many training and further development opportunities were provided for us. It was the first time we felt that we had the opportunity of not being just *"da gong zai"* workers (low status migrant workers) and that we would be valued *here if we wanted to learn"*. (Sho, 010a) *"I sti*ll remember how excited I was about being part of the change. They painted a fascinating picture of how the future would be. To be part of the change, we needed to learn many new things. It was like starting from the beginning again. We all have the same starting point and it's about how much we learn, how quickly we learn makes us ahead of everyone else. I remember there were a lot of passionate discussions at work and after work about how we we*re going to make a difference"*. (Tie, 007a) *"People often prioritize* technology over everything. To me, it is the culture that makes a difference. Technology is just technology, I am not saying that it is not important. What I am saying is that it's about how people use the technology, how people think differently to maximize the benefits that technology may bring. We want people to get thirsty (for learning). W*e want people to get excited about the idea". (Tie, 003a)*

Table 5 Phase 2- Focusing on resource transformation: core capabilities and illustrative quotes

Core capabilities	Illustrative quotes
Experimentation	*"When* electricity was invented, Ford completely changed the assembly line and transformed the whole production process. The same can be applied to the smart manufacturing era. But there is no best practice available for us to learn from. We need to think differently about the layout of the production floor, the sequences of the job, and we have to learn it bit by bit to see what works*"*. (Sho, 012a) *"When we* were first trying out the new production process of mass customization, repair rates were reaching 80%. Now we have made a gradual improvement to lower it down to around 50%. I know, we still have a long way to go. We just have to be persistent and patient. There was no magic solution that we could pick up within a short period of time. We have to keep trying. You *learn from your mistakes"*. (Tie, 016a) *"Having the right techn*ology and equipment is only step 1, how to maximize the efficiency of such tangible asset is step 2. People forget that Industry 4.0 is not a standard process, *it'*s a data driven process. You have different data sets from a different consumption environment, so how you design your operation has to be different as well. Simply relying on imported technology is definitely not the answer. You have to figure things out bit by bit to see how they can work to their *best potential". (Sho, 005a).*
Divesting the existing resource base	*"We have been i*nvesting quite heavily in our operations ever since our company was first established. However, when you make radical changes, you need to take everything apart to see how it contributes to our next strategic goal. Then you have a lot of *chopping to do".* (Tie, 009b) *"It i*s hard when it comes down to money. All the machines and equipment, the operations processes that took years to build. You can*'*t be like a hoarder and want to keep everything just because you paid for it. You need to trim off the unnecessary fat to build up the core *muscle". (Sho, 006*a) *"The decision was not easy to make because we were making good money from our existing resources. We made a list of things th*at were assets in the short, medium and long term to find out which ones could contribute to our core strength. Then the *cutting business began"*. (Tie, 007a)
Building extended networks	*"We rely heavily* on upstream and downstream supply chain networks to produce our products. A chain of network partners were involved in our value chain process. So when you want to make radical moves, you need to think about how it will affect the rest of your supply chain network, or whether you have a network such as suppliers and logistics providers to support your business model. If the answer is no, you better start now to build or res*tructure your network"*. (Tie, 004a) *"Although we* have spent quite a bit of money on our own research and development, it still has a long way to go to catch up with our counterparts in Germany and Japan. We can*'*t just sit there and wait for things to happen. We are very active and get support from the local government in terms of the financial funds and build collaborative relationship with universities for research and development opportunities. We also went to Germany to learn from them. Clumsy birds hav*e to start flying early"*. (Sho, 006b) *"People always associate op*erations with people with hard hats, working hard on the shop floor, with no idea about any parts of the business outside of production. Tho*se days are gone. It's all about connectivity.* When the data and machines are all connected, you are not alone. You are connected with all the data providers outside your company, the suppliers and customers etc. How to build all that, how to integrate it and make it all work seamlessly *is the key".(Ti*e, 011b)

Table 6 Phase 3- Co-evolution with the ecosystem: core capabilities and illustrative quotes

Core capability	Illustrative quotes
Institutionalizing flexible routines	*"*The old days where you closed the doors and focused on manufacturing products are long gone. If you are still running like this, be warned, you are quickly becoming obsolete. The new game is that you need to keep your doors open to connect with your partners, everything is connected now, and things change quickly. You need to build a flexible, simple process or routines to respond to the *change". (Sho, 005b)* *"*Product, equipment, and resources are all networked, and different stages of production are logged, with discrepancies registered automatically. This means that any malfunction, fluctuation in quality or machinery breakdown can be dealt with quickly. You have to have flexible and agile systems or processes to respond to it. Otherwise what is the point of using them*?" (Sho, 006b)* *"*When you move away from mass standardized production to mass customization, it is all about modularization, how quickly and how flexible your operation units can be separated and recombined to produce different products. Modularization includes your production *process, your embedded software and your employees". (Tie, 001b)*
Enriching the firm's resources	*"You have to keep build*ing your portfolio, to see what is valuable out there and how to build it into your portfolio. I believe that we are still at the beginning of a massive change, not just our own firm, not just our industry. It's the whole paradigm, the business paradigm. It is important that we keep absorbing, understanding what is going on and constantly extend what we have to *build up our core strength"*. (Tie, 004b) *"*It is important to identify complementary assets and resources from the market so you need to be constantly looking for new things, and thinking how they could be integrated into your existing assets to create new value. There are many valuable resources out there and the potential is *huge".* (Tie, 009b) *"While the output is a physical object, it all begins with information, the data. You want to be part of a data* pool to get more value out of your data. It is more valuable when your data is integrated and combined with other datasets, so you have a more accurate and complete *picture of what to do. This data extension will put you in a better position". (Sho, 010b)*
Coordinating extended networks	*"You need to* proactively engage in your network because you are depending on them to make it work. The infrastructure (in China) needs at least 3-5 years to build up so you need to make it happen. We put customers in the middle and build a circle with our partners to design and deliver the best customer experience for *them. So you are constantly in the loop of what is going on".* (Sho, 002b) *"You* build the network. That is the first step. The next step is to coordinate it to build compatibility and harmony, to make sure that what *you are doing is relevant to what they do"*.(Tie, 013a) *"We have to look beyond production and think more about coordination: coordination betwee*n different machines and coordination between the different datasets which come from our partners and our own factory. Even though it is highly automated, coordinating the *process to ensure a constant product flow is the most important thing".* (Sho, 008b)

Figure 1 Timeline of the emergence and evolution of key issues in the transformation process

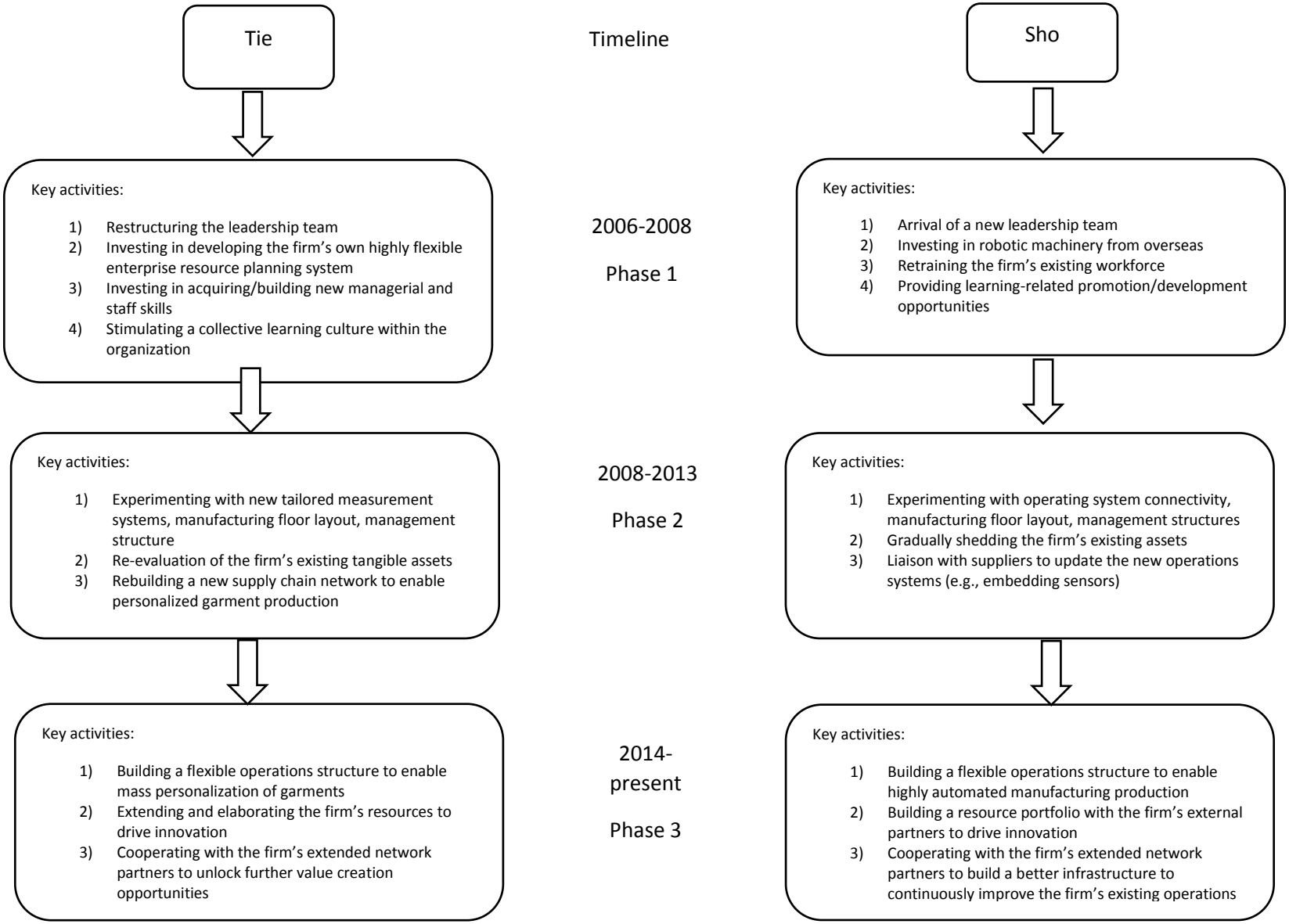

Figure 2 A Process Model of Capability Development