An Investigation to the Industry 4.0 Readiness of Manufacturing Enterprises: The Ongoing Problems of Information Systems Strategic Misalignment

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ABSTRACT

The visions of what constitutes Industry 4.0 is an industry based on gains in efficiency and productivity enhancements supported by integrated, smart information systems. This has caused information systems strategic misalignment that present a severe barrier to national and organizational aspirations. This paper studies the readiness of manufacturing companies for Industry 4.0 by using a case study of Chinese multinational enterprise in the aluminum production sector. The research design follows a rigorous grounded theory approach, which consisted of 41 semi-structured interviews in 7 different company branches. Based on this case study, the paper proposes an IS strategic misalignment model that identifies three levels of misalignment that need to be resolved before the vision of the smart industry can be realized. Six main categories of causes and five main categories of consequences of IS strategic misalignment are presented. This study contributes to the IS alignment literature and provides important implications for the achievement of Industry 4.0 in practice.

KEYWORDS

Case study, Chinese Stated-Owned Enterprises, Industry 4.0, IS Strategic Misalignment, Manufacturing Enterprises

1. INTRODUCTION

Societal and technological developments are experiencing an increasing pace, which bring substantial challenges to Europe's industry, for examples, decreasing availability of natural resources and increasing age of employees ((Erol et al., 2016). As the world's largest producer of manufactured goods, China is not the strongest in high-tech arena comparing with the US, Germany and Japan, which have deployed digital technology to create new industrial environment effectively (Li et al., 2018; Weyer et al., 2015). Moreover, China also faces new challenges as economic growth slows, wages and other factor costs rise, value chains become more complex, and consumers grow more sophisticated and demanding. German introduce the visionary concept of a Fourth Industry Revolution (Industry

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4.0) during the Hannover Fair event in 2011 (Qin et al., 2016), in order to tackle the problems and challenges that Europe's industry is facing. To implement the ideas of Industry 4.0 in China, Chinese government proposed "China Manufacture 2025". This program aims at moving away from a previous generation of manufacturing that was based on cheap production, low quality of goods and lower labour costs into an era of producing higher value products and brand construction based on Chinese research and development (R&D) (Zhou, 2015; China's State Council Report, 2015).

Recent information technology development, such as the Internet of Things, Industrial Internet, Cloud-based Manufacturing and Smart Manufacturing address the requirements of digital integration and intelligentization of manufacturing processes, which are able to operate in a partly autonomous and intelligent way with minimal manual interventions (Schumacher et al., 2016; Lanza et al., 2015; Monostori, 2014). Industry 4.0, that subsumes these ideas, refers to the technological advances in which the internet and supporting technologies serve as an anchor to coordinate physical objects, intelligent machines, production lines and human actors across the organizational boundaries to formulate a new intelligent, networked and agile value chain (Schumacher et al., 2016).

Industry 4.0 is in essence a blueprint to upgrade the manufacturing capabilities through advanced industrial manufacturing, increase of industrial capability, use of smart manufacturing, innovation, as well as emphasis on product quality and branding (Huang and He, 2015). In reality, Information technology (IT) has been in continuous state of flux, change and evolution in the last three decades. This fast development of IT has not only provided new opportunities, but also significant challenges, that have framed what we understand today as the Industry 4.0. The integrated use of IT such as artificial intelligence (AI), robotics and Internet of Things (IoT) has changed industrial production in strategic and operational processes tremendously (March and Scudder, 2019; Wollschlaeger et al., 2017; Gilchrist, 2016). Other IT related phenomena, such as Big Data analytics have also deep repercussions in supply chain management (SCM) and customer relationship management (CRM) systems, ranging from changing business models to day-to-day decision making (Waller and Fawcett, 2013).

Therefore, now more than ever, IT becomes the key for organizations to succeed, innovate and improve their competitive advantages. However, organizations are only able to maximize the strategic value of information technology through business-IT alignment (Kivijärvi, 2018). In fact, modern businesses are increasingly relying on IT to improve organizational performance, investing millions of dollars in IT purchases, development and implementation (Shea et al., 2019; Weerasinghe et al. 2018). However, as proven by an equally persistent trail of disaster and disappointment, IT expenditure by itself does not automatically guarantee optimal effects and desired outcomes in innovation and organizational performance. The more illusion, expectations and investments associated with emergent trends such as Industry 4.0, robotics and AI grow, the more a solid understanding and implementation of appropriate strategic Business-IT alignment becomes critical and relevant (Kahre et al. 2017; Weerasinghe et al. 2018).

Therefore concerns about alignment of business strategy with IT purchases and implementation is now surfacing as a fundamental strategic concern and crucial in maximization of effective and efficient utilisation of information technology (Jonathan et al. 2018). This is not a new revelation, since business-IT alignment has been one of the top concerns by organizational practitioners (Reynolds and Yetton, 2015; Nickels, 2004) and also has been studied extensively in research over the last 30 years revealing it to be a pervasive problem (Luftman et al., 2015; Luftman et al., 2010; Gerow et al., 2014; Kappleman et al., 2013; Chan and Reich, 2007; Tallon and Kraemer, 1999; Luftman et al., 1993). This fundamental importance of alignment for organisational effectiveness is repeatedly highlighted in the information systems' literature (Liang et al., 2017; Alexandre et al., 2016; Hiekkänen et al., 2013; Chan, 2002) and numerous empirical research has revealed the positive effects of alignment on business performance (Gerow et al., 2014; Yayla and Hu, 2012; Oh and Pinsonneault, 2007; Sabherwal and Chan, 2001).

Consequently, companies need now to study how to implement very clear National strategic guidance that points to specific IT technologies as the solution. Thus questions that need to be addressed urgently by the Chinese industrial sector are linked with:

- readiness to implement this national strategy according to their installed infrastructures, labor force and business environment;
- capacity to align these proposed technologies with their own national local strategies; and
- capability to actually introduce these without complete disruption of their current practices.

This paper addresses the question of IT strategic alignment in the light of readiness to implement National guidance. It uses a case-study of a very large SOE and studies problems of strategic misalignment. A conceptual model of information systems strategic misalignment is proposed in next section. Based on this conceptual understanding, the symptoms, causes and consequences of misalignment are investigated in a real case of the Chinese SOE group. This is then followed by a discussion of readiness to implement the Industry 4.0.

2. LITERATURE REVIEW

2.1 Industry 4.0 and Strategic Misalignment

The far reaching vision of Industry 4.0 increases the complexity of manufacturing processes and brings substantial challenges to manufacturing enterprises (Schumacher et al., 2016; Schuh, 2014). Lin et al. (2018) investigate the strategic response to Industry 4.0 in Chinese automotive industry and find out company nature do not increase the use of advanced production technologies, which indicate a strategic guidance is crucial in Industry 4.0 implementation. Moreover, the concepts and ideas embedded in Industry 4.0 require coordination among organizations. The idea of digital integration require fully integrated factories and machines, which means integration comes about both in horizontal level, that integrates all participants across the entire value chain; and in vertical level, it integrates all layers of automatic production (Schumacher et al., 2016). However, when Germany which has recognized the potential of Industry 4.0 presents solutions of its implementation, these solutions are based on vendor-specific or isolated production systems. Meanwhile, open and standardized solutions based on highly flexible, multi-vendor production lines are crucial to the success of Industry 4.0 (Weyer et al., 2015). All these issues indicate strategic alignment and strategy implementation aligned with Industry 4.0 are extremely important for the achievement of Industry 4.0 vision. However, studies have continuously reported strategic misalignment in real cases. Several strategic orientation workshops have experienced that companies have serious difficulties to understand the particular concepts and overall idea of Industry 4.0 (Erol et al., 2016). Although Industry 4.0 has impacted manufacturing enterprises on strategic and operational levels, they are not able to relate the concept and idea of Industry 4.0 to their business strategy and they fail to identify concrete development stages such as action, programs and projects with regard to the Industry 4.0 (Erol et al., 2016). It is necessary to investigate strategic misalignment situation in manufacturing enterprises and provide guidance and support to align business strategies and operations so as to achieve Industry 4.0.

2.2 Conceptualizing Information Systems Strategic Misalignment

Although the issues about how to achieve business-IT alignment in organizations have drawn much attention in research (Coltman et al., 2015; Gutierrez and Serrano, 2008; Benbya & McKelvey, 2006; Maes et al., 2000; Henderson and Vankatraman, 1990), the achievement and maintenance of alignment is still a problem (Carvalho & Sousa, 2008; Pereira & Sousa, 2003). Due to dynamic changes in environment and organizations, especially the turbulent market environment, pervasive digital innovation, it is more challenging for the organizations to achieve IS strategic alignment

(Zhang et al., 2018). Correspondingly, it is argued misalignment analysis is an effective way to manage business-IT alignment, which also presents its coevolutionary nature (Zhang et al., 2018). However, scholars have made great efforts on achievement of alignment with little contribution on how to identify and understand misalignment. Only a few authors studied misalignment to address the alignment problems. The misalignment analysis follows a detection, correction and prevention process in the literature (Ori, 2014; Carvalho & Sousa, 2008). The misalignment detection receives the most discussion (Zhang et al., 2018), with proposition of a series of misalignment symptoms (Ori, 2016; Luftman, 2003). Nevertheless, these symptoms are identified without a clear conceptualization of misalignment. Moreover, to correct and prevent misalignment is rarely discussed in prior studies.

All the development of alignment concepts considered how to achieve alignment in the organization and the ways of alignment impacts business performance (Gerow et al., 2015, 2014; Bergeron et al., 2004; Maes, 2000; Henderson and Venkatraman, 1993). However, they have done little for practical guidance or methods to improve the IT value or manage the misalignment in the organizations. Chen et al. (2005) developed Business IT Alignment Method that can be used to assess the misalignment and propose realignment in operational level. However, this model only emphasizes architecture perspective. Carvalho & Sousa (2008) proposed business and information systems misalignment model and made efforts to correct misalignment in medical approach with nomenclature, classification and management components. Nevertheless, the detection of misalignment in this model is carried out without a clarification of the concepts of misalignment. To identify the misalignment situation, the misalignment concepts are revisited and a strategic misalignment model is developed, as in Figure 1.

Figure 1. IS strategic misalignment model

To be specific, in the proposed model, IS strategic misalignment is considered as a multi-dimensional concept at the strategic, structural and operational levels. The strategic misalignment mainly concerns the mission, scope, governance and core capabilities of business and IT. Structural level misalignment involves the concerns for the architectures and capabilities of business and IS. In structural level, the alignment state between IS application structure and organizational structure and management hierarchies is considered. Structural level aims not only at the alignment state between of IS and business structure but also at the support IS and business structure gives to the organisational objectives (Chan, 2002). For operational misalignment, it is simply proposed as processes and skills involved in. In addition, Luftman (2000) stated that variables such as how business activities operate or flow, and especially value-added activities and process improvements, human resources considerations and culture, should be included in the processes and skills factors. In particular, the degree of fit between IS infrastructure and business operations is one of the important perspectives in business-IT misalignment. It indicates that the extent to which IS infrastructure support business operations and different functional units such as sales, finance, manufacturing, and human resources

areas; while on the other hand, IS infrastructure is also influenced when there are changes in business operations. This research adopted this updated conceptual understanding of IS strategic misalignment as the basis to investigate the misalignment situation and the related causes and consequences in a post-merger State-Owned Enterprise (SOE) group.

3. RESEARCH DESIGN

3.1 Research Context

With a consistent growth of economy at an average annual growth rate nearly 10% in the last three decades, China now is in a fast-developed economy comparing with the western developed countries. Under this environmental challenge, State-Owned Enterprises (SOEs) are operating as a leading economic component in China. Regarding to the growth of the non-state sectors and the merger reforms, the SOEs in China have been shrinking (Ralston et al., 2006). Nevertheless, SOEs still have a dominant presence in several key industries in China, including automotive, pharmaceutical, electronics and petrochemical after these reforms (Ralston et al., 2006; Nolan, 2001). These sectors are viewed by the state as having strategic values; therefore, SOEs still contribute significantly to the Chinese economy (Ralston et al., 2006). In early 1990s, the central government decided to list some large state-owned forms while sell off small ones or low-profit and loss-making ones (Peng, 2007; Lin et al., 2001). Chinese government proposed a merger plan for SOEs in the 15th National Congress in 1997, which aims to integrate the SOEs so as to make them more competitive. After merger and acquisition over the next few years, the number of SOEs subordinate to the central government reduced from 196 to 123 during the period 2003 to 2010 (Saidi consultant, 2010). There are 30 Chinese SOEs included in the top 500 enterprises of the world following the mergers in 2010 and this number increased to 83 in 2015 (Peng 2016; Saidi consultant, 2010). It is clear that, following the mergers and acquisitions, the capacities for global competition by Chinese SOEs have increased.

Chinese SOEs have their special features. Firstly, Chinese SOEs still bear social responsibilities. SOEs are not allowed to fire the employees therefore bear a heavy burden from redundant workers, retirement pensions and other social welfare costs (Lin et al., 1998). Secondly, the information systems implementation and management changes in Chinese SOEs have been conducted according to a governmental plan rather than as the result of market competition (He, 1998). Thirdly, Chinese SOEs have experienced a series of reforms. From 1992, the reform mainly focused on building a market-oriented modern enterprise system in SOEs (Peng, 2009). In 1997, the Chinese government proposed a merger plan for SOEs so as to increase their capacities from merger and acquisition (Ye, 2009). On one hand, they are becoming larger and competitive after the merger plan proposed by the government. On the other hand, they are facing more and more competitive environment under the market-oriented enterprise system.

The fact that IS implementation in Chinese SOEs is decided by the national strategy rather than organizational strategy or business requirements indicates the necessity and importance to investigate the state of IS strategic alignment so as to make clear the readiness of Industry 4.0 in Chinese SOE.

3.2 Case Illustration

This research project selected a key state-owned enterprise supervised by the central Chinese government directly as the case study site. The headquarters and branches of the Corporation are distributed over 22 provinces in China and operated in more than 20 countries and regions with different businesses. It was made up of seven enterprises that are producers and one research institute when it was established in 2001. This study focused on the headquarters in Beijing that is mainly responsible for the management and original seven manufacturing branches since the research institute has no production function. These seven branches are geographically dispersed in six provinces including Shanxi, Shandong, Henan, Guizhou, Guangxi and Qinghai in China.

The selected SOE group are playing a significant role both in strategic and economic perspectives. In China's economic reform aiming to sustain economic growth and social stability, SOEs' reforms and development are major concerns (Dong, 2000; Lin et al., 2001, 1996). Chinese government paid much attention to information technology and has invested heavily on construction of the IT infrastructure. As a typical enterprise in government's merger plan, the implementation and integration of information systems needs to be investigated in the merged group environment. Especially, manufacturing practices are evolved with advancements in IT rapidly nowadays (Tatipala et al., 2018). Products in new generation require higher quality, shorter time for development, customization and improved performance in Industry 4.0 trend (Tatipala et al., 2018; Stefan, 2017). This kind of context indicates just how much the investigation of business-IT alignment state in Chinese SOEs is essential to assist successful information systems implementation and information technology innovation so as to improve the business performance of the organization.

3.3 Data Collection

Interviews were used as the data collection method. Interviews were selected as the method of data collection as it would enable frank, anonymous and face-to-face exploration of issues with the interviewees. Following the theoretical sampling strategy in Strauss and Corbin (1998) approach, a total of 41 interviews were conducted in headquarters as well as all seven branches. Interviews were conducted with managers and staff in both business departments and IT department. Interviews were conducted in Mandarin Chinese and the duration was from 40 to 60 minutes in general. Researchers travelled all the seven branches and headquarters to conduct interviews. The details of interviewees are included in Table 1.

Table 1. Interviewees summary

Headquarters or branches	Henan	Zhong-zhou	Guang-xi	Shan-dong	Shan-xi	Qing-hai	Gui-zhou	Headquarters
Number of participates	21	4	2	4	2	2	2	4
Functional department	IT department				Functional department			
	20				21			
Management positions	Managers				Operational staff			
	29				12			

Data collection processes are supported by two important tools, interview question script and digital recorder. The researcher used interview script to guide information gathering when conducting interviews. All interviews were recorded with a digital recorder. The digital recordings were transcribed into Word files and then assigned into Nvivo for data analysis, which is discussed in detail in next section. The data collection and data analysis were conducted concurrently. Participants were approached individually in groups of three or four, based on the need for theory formulation reflected by the data analysis. After each set of interviews, the interview data were immediately transcribed and a brief analysis conducted. The analysis results were used to revise the interview script and to guide further sampling. The data collection was stopped when it was perceived that the theoretical saturation had been achieved, as seen in Figure 2.

Figure 2. Theoretical sampling and saturation

3.4 Data Analysis

Coding is used for the data analysis with grounded theory approach. There are three types of coding adopted in data analysis with Strauss and Corbin (1998) approach, including open coding, axial coding and selective coding. In addition, there are four supporting tools used to support the data analysis practise, including data analysis software (Nvivo10), code definition table, quotation list, and concept map. The use of NVivo increases the effectiveness and efficiency of way of learning from data. Researchers reported software provided new ways of seeing data comparing with the time managing data without software. Researcher adopted NVivo to read and manage data. Furthermore, the open coding processes were conducted with this software.

The code definition table includes the following information: the definition for each code, the relation of codes to sub-categories, categories. The code definition table supported the constant comparisons in data analysis process. The codes were clearly defined and presented in the table. When researcher identified new codes from the data, the new emerging one was compared with the existing ones clearly based on the definition. The results of comparisons decided to add the codes as a new one or merge it with the existing one. Furthermore, the codes were related to the sub-categories, categories at the level of properties and dimensions. This code definition table presented clear relationships among codes, sub-categories, categories. Researcher used this table to support open coding and axial coding in this research.

Quotation list was used to record the quotation for each open code, as shown in figure. Quotation list also supported the constant comparisons in data analysis. When a new quotation was identified to an open code, it was compared with the existing quotations on the list to find out which one is better present the meaning of the code. Through the comparisons, the definition of codes may be revised, or sometimes a new code would be added if actually the quotation presented a different concept.

Concepts map is a visual device used to present the relationships among concepts, sub-categories and categories. Concept map helped researcher to analyse all the relationships explicitly, compare and validate the connections among concepts, sub-categories and categories. On the other hand, concept maps are product of axial coding and an integral part of the findings. These maps are the findings of the research.

4. RESEARCH FINDINGS

Findings of interpretivist research are usually presented in rhetorical form. The findings presented below were constructed using concept map as the scaffolding tool and quotes from the interviews as anecdotal evidence to qualify the argumentation.

4.1 IS Strategic Misalignment Situations

The aluminium industry is not in a very good situation and the SOE group are operating in a period of winter time when the study was conducted. “The price in market is not good these years; especially as the benefits are influenced a lot (N39 Manager IT H)”. Therefore, three tranches of reform took place in order to simplify the organizational structure and increase competitive strength.

4.1.1 Business Strategy and IS Strategy Change

In addition to the organisational reforms, the business strategy in the SOE group has changed since 2002, when the corporation became one of the listed companies. Up to the present, there are two main obvious changes of business strategy. Firstly,

“[the corporation] is trying to achieve product diversification and sustainable development. Previously we only had alumina. Now, as well as alumina, aluminium hydroxide, we have Metal gallium... (N13 Manager Function)”

Secondly, a centralized control undertaken when the corporation started to be listed companies has changed to strategic control for management.

“When ERP was built there was only aluminium business and at that time the management idea was centralized control... At that time, the corporation needed restructuring in order to be listed on the stock market. The first goal for restructuring is to institute unified management. (N40 Manager IT H)”

To be specific, the centralised control requires “financial centralized management, centralized management of funds, investment centralized management and centralized management of purchasing and sales in headquarters. (N28 Manager Function)” Furthermore, the roles branches play in the SOE group under centralized management are similar to manufacturing plants: “We are actually a factory. It means headquarters consider the strategy. We are just cost centre for them or a production plant. (N14 Manager Function)”

However, along with market-oriented reforms and market development, the SOE group is growing, and the business strategy changed to “strategic control” (N40 Manager IT H), which means “headquarters formulate the strategic objectives and performance assessment objectives” (N40 Manager IT H), and all the branches “self-manage the business” (N41 Manager IT H). Along with the development of enterprises and markets, centralised management is not suitable to manage different branches located in various cities in large area of China. Strategic control is used instead in order to activate the enthusiasm of the branches.

Correspondingly, there was an IS strategy change with the business strategy changes at headquarters. Previously, the IS strategy was formulated in headquarters while branches implemented the IS strategy with a few developments for some special IS projects, based on individual requirements.

“The IS strategy for the SOE group are made in IT department in Beijing. (N7 Manager IT)”

“We all comply with the strategy command in headquarters. We must not deviate from it since there is a master plan. It means our plan is an implementation under on overall plan in headquarters.” (N8 Manager IT)

However, as mentioned, a new business strategy ‘strategic control’ was proposed in 2010. In the same year, IT department in headquarters made the new IS strategy to support the business strategy. The branches also need to consider the IS development plan themselves, as headquarters do not generate IS plans for them in this situation.

“The current operation mode in the corporation is self-management, which means that whatever the business branches want to do, they take responsibility themselves (N41 Manager IT H).”

The headquarters “were in charge of the budget in branches. In terms of what they are going to build, we are not helping (N41 Manager IT H).” Headquarters no longer participate in decision-making on the IS development plan in headquarters. Branches need to consider the IS construction and development plan themselves. However, headquarters take responsibility of the IS development budget. It is perceived that it will influence the strategic and creative thinking of IS development in branches if there is a lack of good communication between headquarters and branches.

To summarise, the corporation has experienced both business and IS strategy changes during the past years. Under this situation, the misalignment situation is severe in the organisation. The SOE group now is experiencing a very poor business-IT alignment situation.

4.1.2 Strategic Level Misalignment

It was very surprising to find that a number of staff and managers in enterprises were not clear about the IS strategy contents. Not only operational staff in both IT department and functional departments state “I don’t know (N1 Operational Function)”, or “there are not very clear objectives (N21 Operational IT)” when asking about IS strategy but also the managers in functional departments of branches stated “I do not care about the IS plan, IS strategy concerns. Previously we have reported on it but I did not pay attention to it. It is difficult to find the report now (N16 Manager Function)”. What is worse, even some IT managers were not able to explain the contents of the IS strategy. They just explained, “It is on the official document. I can’t remember it now (N8 Manager IT), or “I can check for you [online] (N5 Manager IT)”. It is found out that operational staff and managers in the enterprises did not pay enough attention to the IS strategy. Headquarters formulated the IS strategy but, in branches, this was not implemented well.

Furthermore, it was found that not only were the staff and managers not clear about the contents of the IS strategy, but also there was a lack of IS strategy implementation to guide the IS use and development in the branches. IS implementation is decided based on the business requirements of the functional departments. There is no strategy used to guide overall planning of IS implementation in the branches.

“It is when there is a need from production or there are any inconveniences requiring IS use, that it is adopted and lack of overall planning (N18 Operation IT)”.

The decision-making on IS implementation in branches is just about whether there is any business requiring the IS project. The IS role still stands at the traditional administrative support level. The enterprises are not using strategic thinking for IS planning.

4.1.3 Structural Level Misalignment

In structural level, the support of IS to management is insufficient in the organization.

As has been presented, there was a business strategy change in the SOE group. All the branches needed to face the markets competition themselves. The managers in the branches needed to consider the situations of markets for better management. “As a manager, you need strong IS support, to facilitate your decision-making (N16 Manager Function).” The manager realised they needed IS to

help them understand the overall situation, based on the business strategy. However, the existing IS applications were not able to fulfil these requirements.

“In fact, when we develop the analysis of IS I feel like we need more extensive data. It should not be limited to the information inside SOE group and also should be more focused on the industry, and international data. (N14 Manager Function).”

Managers need both internal and external information to support analysis, management, and decision-making in enterprises, including long term considerations about strategy. The current IS lack strategic level support. Instead, it was found that the lower level tactical supports which helps vital information selections and provides information for decision-making in enterprises were missing in the systems. “There is a need to select the data.....Just key data needs to be in the system. (N22 Manager Function)”

Furthermore, ERP were not used well in manufacturing. The support of ERP for the main business units in the enterprises was problematic.

“When I was in scheduling meetings, we discussed how many raw materials, fuel, or materials are needed in the current situation, the current consuming situations. It [ERP] just can roughly control, what is the approximate situation (N19 Operation IT).”

It is very surprising to find materials scheduling and inventory management are still in an unsatisfactory situation in enterprises, even after ERP implementation. It is perceived that the main focus of ERP use was on centralised management in headquarters. The manufacturing support, which was extremely important in the branches, was not paid much attention, in comparison.

4.1.4 Operational Level Misalignment

When managers allocated the work they needed to consider the operational skills of staff. Some could only do the work using simple functions. Furthermore, some people were just able to use the systems functions to support the work in their own roles, so when they changed their posts, the operation became problematic.

“But if there is a job adjustment, it is very difficult for them to adapt to it because they usually work in the area they are familiar with, when they are given another post, they are not able to get very comprehensive knowledge. (N24 Manager Function)”

We can thus say that staff in these enterprises did not have a “comprehensive knowledge” of the systems, but were only familiar with the operations of some functions. It indicates that some staff actually did not understand IS well and they just learned the operations mechanically. In this case, the cost of personnel change in the enterprises was higher than previously, since staff needed more time to adapt to the new job.

4.2 Causes of Misalignment

4.2.1 Non-Strategic Role of IT

The IS are still in the traditional backup or complementary position in the case SOE group. IS was not able to be in a very important position in manufacturing enterprises and “it is actually icing on the cake in some industries (N11 Manager IT)”.

“In this industry, the main business of the enterprise is manufacturing. No matter how important the IS are, they cannot reach that kind of level. They just provide services to production.” (N12 Operation IT)

Even in headquarters, some of the interviewees understood the IS position similarly.

“As the manufacturing enterprises, the traditional types, it [IT] is just used as a tool. Its role in the production is just to improve the management, make it better. For others, I don’t think there are more advantages. (N41 Manager IT H)”

4.2.2 Poor IT Governance

IS management job division was not reasonable in the SOE group under the prevailing conditions. The IT department in headquarters takes the responsibilities of ERP management while IT departments in branches are mainly in charge of hardware and network maintenance.

“This issue is considered in headquarters as a whole because ERP systems are under unified management in headquarters and we just implement it (N33 Manager IT).”

“For the software maintenance inside the systems, in fact there is an IT department at headquarters. They instruct, manage and complete directly. It means the IT department in branches are not authorised to do so. They are mainly doing hardware maintenance (N27 Manager Function).”

ERP systems are managed in headquarters, while IT departments in branches are responsible for hardware maintenance. Therefore, for ERP implementation issues, the IT department in branches is just able to solve IT problems rather than IS problems. Just a few responsibilities of IS management are taken by IT department in branches. Even for maintenance, the IT department in branches is just responsible for hardware and networks.

Furthermore, IT departments in both branches and headquarters were in a service or support position without organizational strategic management responsibilities.

“You can think about it [IT department] as a service department, just a bit better than branches and leaves. Not only us, in all the companies, it’s important orally but not paid attention to in reality (N41 Manager IT H).”

For the decision-making on IT project, “basically, we make the project and then apply for the funds to see if it’s approved from corporate managers (N41 Manager IT H).” IT department in headquarters was not able to make decisions on IT project implementation. The projects needed to be approved by business managers. the IT department in both branches and headquarters was in a service position, therefore the IS strategy was not given enough attention for strategic management in the organization. Moreover, the IS strategy made in headquarters is being ignored in branches.

4.2.3 IS Use Motivation

The corporation made large investments on IS implementation when it was built “in order to achieve the demands of listed company” (N11 Manager IT). The main aim of the IS implementation was for headquarters to strengthen the centralised management. The manufacturing systems which supported the main business sector in branches was actually not the focus of IS implementation, as decided in headquarters. When talking about the reason that the manufacturing system was not paid enough attention, one of the IT managers stated:

“It is because branches existed first and then the Corporation of China was built. The Corporation of China cares about centralized management... through ERP. The corporation is not interested in the manufacturing system. It’s very simple. The corporation does not make investment in it.” (N33 Manager IT)

As reflected in the quotation, the Corporation of China was established in a typical Chinese way. The seven branches already existed and operated and then were merged together as one corporation, which resulted in the corporation being built, the main concern of managers was centralized management. In this case, manufacturing IS are not given enough attention in headquarters.

4.2.4 Traditional Management Ideas

It is found out in the case company, the attitudes of managers to IS use are negative. They are resistant of work with IS. Traditional management ideas and culture are influential in Chinese enterprises.

“For our management, many things are still done based on the traditional manual management idea, ignoring the value of system management. (N40 Manager IT H)”

Managers ignored the changes in management approaches after IS adoption. Managers need to pay more attention to the management using systems. In addition, IS use impairs the rights of managers.

“Before ERP implementation, managers of branches were afraid that their rights would be impaired. Actually after ERP implementation the rights of managers did weaken... Every cent you spent is on the account. You can’t avoid it. You should submit all of them and it’s impossible to save any. (N35 Manager IT)”

It is found that managers in branches have fewer rights after ERP implementation. This is one of the reasons that managers are resistant to using IS. Since management with systems does not comply with their ways of doing things and also reduces their rights, managers in enterprises do not pay attention to understanding and using IS for management purposes.

4.2.5 Culture

Chinese way of thinking and culture influence their ways of doing things, which results in the situation that managers are reluctant to change management style.

“Where is the most difficult part of IS development, the barrier of IS development. It is actually people’s thinking. People always think of shortcuts, think about simplifying... . Our product is from SAP, German.....Everyone considers it’s very difficult to use, very rigid. They all prefer Oracle from USA. You can have customization in Oracle. Americans are better than Germans, they are more flexible. But Chinese people are too flexible, excessively flexible (N31 Manager IT).”

“Flexible” is the Chinese ways of doing things. A lot of factors influence the activities and decision-making of managers, such as “shortcuts” or “personal contact”. Managers are used to deal with things flexibly since they need to consider different factors under various situations. IS processes are strict and stable therefore they are resistant to using them.

4.2.6 Organizational Structure

The SOE group implemented a centralized management strategy from 2002 when it was built, until 2010. Under the centralized management, branches play the role of “production plant” (N14 Manager

Functions) in the SOE group. They do not need to consider the financial issues, funds, investment, purchasing and sales. All of these issues are managed at headquarters. Furthermore, IS implementation was planned under the circumstance of centralised management when the SOE group was built in 2002. At that time ERP was implemented to support management in headquarters.

“When ERP was built there was only the aluminium business and at that time the management idea is centralized control.” (N40 Manager IT H)

Since the implementation of the main IS application ERP, this has been decided under centralized management, for which branches are considered as “cost centre” (N14 Manager Function). IS applications do not support the tactical and strategic level management in branches. However, “there are only several hundreds of staffs in headquarters” (N40 Manager IT H) and 110,000 employees in the whole corporation in 2010. Furthermore, the seven branches were built independently and distributed in different areas in China, business distinctiveness was obvious among the branches.

“Each branch is different in development progress.....Based on the development mode and development status, different branch has their own characteristics. Some have better IS development while for some IS development is primitive and slow. (N19 Operation IT)”

Since different branches have various manufacturing characteristics and IS development situations; it's difficult for headquarters develop the manufacturing systems uniformly.

“The production characteristics, equipment characteristics and the producing procedures are different in each enterprise. There is a lack of a standardized [software], such as SAP. We can't find such standardized software. Each enterprise uses more custom development. (N39 Manager IT H)”

Thus, distinctiveness of different branches results in the difficulties of unified construction of manufacturing systems in headquarters. It is also claimed that it lacked unified construction because there was no standardized software which could be used, considering the varieties of branches. Although these can be seen as the reasons for lack of investment in manufacturing IS by headquarters, these were not the reasons why headquarters did not pay attention to manufacturing IS. More focus on the management and ignoring the manufacturing in branches were more important reasons for lack of investment in manufacturing systems at headquarters.

4.2.7 Training Problems

A number of interviewees considered that training was insufficient in the enterprises, including managers and operational people.

“Maybe there was a lot of training when they first implemented it. Afterwards.....it was impossible to put on so much training. But when there are many staff changes, the business may become problematic.” (N15 Operation Function)

“The current situation is there is no training for new staff. You just learn it when you handover, there is no special training.” (N20 Manager Function)

It is shown in the quotations above that, when there were situations of new staff coming or staff changing to a new post, there was no induction training. When there are frequent reforms and staff mobility in enterprises, business activities and operations are impacted negatively.

4.3 Consequences of Misalignment

4.3.1 Less IS Business Value

The IS investment is considered to involve investing in management or supportive tools or functions, rather than to increase the competitive strengths or help to find out new market positioning. It was found in the enterprises, that managers and staff were not clear about the IS/IT investment values.

“IS are just playing assisting roles. If you claim IS are able to improve profitability, this is not realistic, not playing such a big role. (N24 Manager Function)”

The IS value was just considered as “a replacement for manual work, releasing the labour for operational people” (N1 Operation Function). For managers, IS were not able to “improve the profitability” or “create values” (N3 Manager Function, N24 Manager Function). IS values are underestimated in the enterprises. In addition, the benefits acquired from IS implementation are decreased and the values that are created through an integrated system are missing.

“IS, in another word, before IS implementation, the enterprises worked well, operated well, it means [IS had] no influence. But after implementation it will be better. In the current situation [bad business performance] why would we implement IS? (N18 Operation IT)”

It is found out that staff in the organisation consider the enterprises worked well without IS implementation. Since the current IS was mainly used for management rather than production processes, IS had “no influence” on the operation. In this case, when enterprises were losing money, investment could not be made on IS since IS was not essential in the enterprises.

“If the IS development is not combined with competitive advantage, which means with the main business, with the central issues, inevitably, it will be marginalized. (N11 Manager IT)”

IS applications did not support central management, which is crucial misalignment problem. IS was not generally considered to combine with production processes in the manufacturing enterprises, therefore the IS use was considered as an additional service.

4.3.2 Low IS Capability

Without respect of the IS implementation based on the IS strategy made in the headquarters, in branches the IS are adopted with a lack of common goals or a unified plan, which results in two main problems in enterprises. In branches, there is a phenomenon that some developed systems are ignored. It has been mentioned that they had some implemented systems, such as “equipment inspection IS” (N12 Operation IT), “Barcode management IS” (N25 Manager IT), and “Digital achieves” (N9 Operation IT), which were implemented based on their decisions rather than planned from headquarters. However, these systems were abandoned or not well used. These systems are not decided based on the IS strategy known from top executives to operational staff, therefore, importance is not attached to their implementations.

“Because these are small projects, people do not use them. But if the systems are developed for everyone, the situation will not be like this. If developed just for a small part of them, and those we developed ourselves, when they consider the systems are not easy to use, they do not use them. (N25 Manager IT)”

People did not pay attention to the systems, which were implemented without clear strategy guidance. As a consequence, the resources spent on IS development were wasted while the beneficial results were not acquired.

Furthermore, since these systems were developed without an overall plan, the phenomenon of “islands of automation” occurred. Lack of IS strategy in branches results in the IS phenomenon of “islands of automation”. It refers to the current IS use phenomenon in the branches, where IS applications are developed using different hardware, software and data resources and these isolated IS are run separately, without communications or data and information sharing.

“Because now many IS in enterprises seem not fully integrated. It means they are not creating the values there should be. I feel sad about this. Many things after developed which just some people are using, in a small area, not fully playing their roles. (N12 Operation IT)”

There were some isolated IS applications applied in the branches. Since there were not unified plans for implementation, these applications were not integrated. These isolated systems actually brought inconvenience to the users and IS staff, such as data and information management troubles.

4.3.3 Low Organizational Dynamic Capabilities

The organisational dynamic capabilities are also negatively influenced because of misalignment.

“Currently there are many staff changes...For IS implementation, the easier the operations are, the better the enterprise is. The more complicated the operations are, the more likely it is for something to go wrong.” (N15 Operation Function)

Since staff were not skilful enough to do the operations, it was claimed that the operations would have been easier to facilitate in the enterprise business. It is perceived that the low capabilities of operational staff increased the risks in IS use and may have brought troubles to business operations.

5. DISCUSSIONS AND CONCLUSIONS

Based on the findings above, the integration of findings is shown in the causes and consequences of IS strategic alignment model in Figure 3 below.

Figure 3. Proposed causes and consequences on IS strategic misalignment model

The proposed model represents the multifaceted and co-evolutionary nature of IS strategic misalignment and further shows the complex mutual influences between IS and business domains in the organizations that may operate simultaneously. IS alignment process is influenced at multiple levels in the organizations. There are multi-directional causalities within a complex of relationships rather than a simple cause-effect logic of linear relations between independent and dependent variables. Strategies changes require adaptations at all different levels. Different types of factor are influencing different levels of alignment. The higher levels of misalignment further impact lower level of misalignment. These interactions may be recursive and result in interdependencies and circular causality.

The complicated misalignment situation indicates the difficulties to implement Industry 4.0 in Chinese SOEs. Here it is argued that the vision of Industry 4.0 contributes to strategic value of organization from the strategic, structural and operational levels of business-IT alignment. In the current situation, organizations have very few capabilities to align the Industry 4.0 plan and technologies to support and shape their business strategies. For examples, the strategy implementation and IT governance processes both have problems with the Industry 4.0 achievement; the connections of various information systems as well as the connection between the automatic production systems and management systems need to be improved; the trainings and skills of the employees impact the Industry 4.0 achievement negatively.

The model proposed in this study shows organizations adopt Industry 4.0 technologies to improve their operational, managerial and strategic performance. Furthermore, the influencing factors and alignment approach are different in practice in real life organizations. It is inferred that organizations may acquire unique advantages from their alignment process to support strategic objectives. For instance, for organizations to gain management differences, an organizational infrastructure that enables innovative actions and strategies, IT management skills, and getting their people to embrace the right behaviours and values for working with information based on the characteristics of the organization (Marchand et al., 2000; Dvorak et al., 1997; Kettinger et al., 1994; Keen, 1993). Moreover, the IS strategic alignment process shown in the proposed model connects all the strategic, structural and operational levels; these elements are interrelated and therefore influence each other. Furthermore, it is argued that alignment, as well as the Industry 4.0 implementation are likely to be different in various organizations and various industries or sectors when it is approached as a process (Bergeron et al., 2001; Tallon, 2007), since the influencing factors of IS strategic alignment identified may vary in different cases. In addition, causes and consequences identified related to three different levels of misalignment indicate the advantage and necessity of conceptualizing misalignment at the process level, including structural and operational levels. Some of these causes and consequences have impacted the case SOE group on different ways comparing with the impact factors of alignment in the literature, which shows the alignment approach is context-dependent and there is no one design of the alignment approach fits all contexts. However, there are still limitations in this paper. The causes and consequences factors are explored in the SOEs case. It is meaningful to find out particular impact factors in various contexts.

Furthermore, this paper mainly focuses on the identification of causes and consequences factors. More emphasis to find out what the most important causes and consequences are would be very useful to improve the IS strategic misalignment situation. These studies would be carried out in future research.

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