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Digital Manufacturing Transformation Strategy of State-Owned Enterprises (SOEs) in China

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ABSTRACT

In order to gain competitive advantage, executives in state-owned manufacturing enterprises in China are seeking various approaches to speed up the digital transformation. Under the dynamic and turbulent business environments in China, digital manufacturing transformation offers many opportunities as well as challenges. China Tobacco Shandong Industrial (CTSI) Corp. is selected to generalize the phenomenon of digital manufacturing transformation strategy in China. The case study is to investigate the features and drivers that make the digital manufacturing transformation happen in Chinese state-owned enterprises.

KEYWORDS: Digital manufacturing transformation, State-owned enterprises, China, CTSI

INTRODUCTION

China plays a more and more important role in the world economy. State-owned enterprises greatly contribute to the development of China economy. Because of the special position in China, State-owned enterprises (SOEs) are integral to China’s economy prosperity. Unlike the developed countries, China is still exploring how to use information technology (IT) to reinforce its innovation capabilities.

Even though the Chinese government had taken measures to downsize state-owned enterprises in early 1990s, state-owned enterprise ownership is still dominating the major business activities in China (Guthrie, 2012). As of 2011, over 43% of profits generated by companies in China were state-owned. In 2014, there are over 30,000 stated-owned enterprises in China that produce half of the national goods and services. Sixty-five of the Chinese companies in the 2012 Fortune Global 500 list were state-owned. Profits from the largest state-owned enterprises are much greater than the private enterprises in China.

Since early 2000s, more and more stated-owned manufacturing enterprises in China had begun to reform in many aspects. To align with the business strategy, IT strategy at that time centered on enterprise information systems adoption to improve production efficiency. In last decades, America was the largest manufacturing economy in the world manufacturing industry. Since 2010, China has overtaken the U.S. and ranked first in the global manufacturing industry. According to the report, the output value of Chinese manufacturing occupied 22.4 percent in the
world manufacturing activity (MAPI, 2014). Although China has made the largest output in the
world manufacturing industry, its efficiency of production is still at a low level. This is also a
universal problem for the other developing countries. From the indicator of per capital output in
manufacturing, China is only one in eight of that of the United States.

As is widely acknowledged, technology is intertwined in most business activities. Digitalization
as a process of technology application has changed the pattern that firms operate in almost
every industry. Evidence indicates that digitalization has become the first important factor that
drives the transformation of global manufacturing industry. Thus, it is imperative for China to
transform the production mode by the digitalization process.

Unlike other examples of digitalization involving the conversion process from physical products
into digitally deliverable products, digitalization in manufacturing is the digital process by
implanting IT into manufacturing devices and equipment (Kohli and Johnson, 2011). It combines
supply chain management with real-time acquired information for decision making (Kohli and
Johnson, 2011). By digitalization, the manufacturing industries can start a production growth
engine, deliver production quality, and finally create customers’ value. It is anticipated that IT
capability would continue to provide a competitive advantage for firms in the 2010s.

Currently, most developing countries are catching up the pace of development of information
technology in order to achieve a leapfrog development. Indeed, newly emerging countries are
just getting started to accelerate this transformation with the governments support. In order to
facilitate the digital inclusion to promote innovation-based economy, governments in developing
countries are enthusiastic to adopt advanced information systems by learning from the practices
of developed countries (Segal, 2003). Yet, because of the culture difference in local business
practices (Marble and Lu, 2007), the adoption can not be well achieved. For instance,
Enterprise Resource Planning (ERP) has been proved that its success in implementation is
strongly determined by cultural fits. Therefore, it is better to have a better understanding for
practitioners about the transformation strategy and learn from the current successful case.

CASE BACKGROUND

Given our research question and the transformation characteristics of state-owned enterprise,
we identify China Tobacco Shandong Industrial Corp. (CTSI), a subsidiary of China Tobacco, as
our target case.

China Tobacco, one of the typical Chinese state-owned enterprises, was founded in 1982 and
administered by the State Tobacco Monopoly Administration (STMA). At present, there are 16
tobacco industrial corporations, 130 cigarette factories and over 900 brands under its control
throughout China. As a virtual monopoly in China, it has become the world's largest
manufacturer of tobacco products. Under the supervision of the STMA, China Tobacco are fully
responsible for marketing, production, distribution, and sales of tobacco products in China.

The reason we chose China Tobacco Shandong Industrial Corp. as a preferable candidate for
exploring Chinese state-owned enterprise transformation is due to its distinctive position and
features in China. Different from other countries, China executes tobacco monopoly policy and
only a small number of foreign firms under license from local tobacco are allowed to enter
Chinese market.

The cigarette industry is of great exceptionality with other industries. The cigarette industry now
contributes to 25 to 50 percent corporate value-added tax. Tobacco taxes are important sources
of national revenue, occupying a great proportion of the national fiscal income. In 2012, the total tobacco tax was about 119 billion dollars, accounting for about 8% of the state revenues. Moreover, the cigarette industry has provided more than 500,000 employment positions. The potential related employment positions driven by cigarette industry are over 6 million. Since the implementation of reform and opening policy in 1978, the cigarette industry has experienced many transformations. Digital manufacturing is one of the important steps among those active transformations.

China Tobacco Shandong Industrial Corp. (CTSI) is a wholly owned subsidiary of China Tobacco. In October 2003, STMA approved the Shandong Government's request and decided to establish China Tobacco Shandong Industrial Corporation, trading as Shandong Tobacco. The headquarters of CTSI is in Jinan, the capital of Shandong province. In early 2004, CTSI earned its official status. Its business scope includes manufacturing and selling cigarettes, trading raw tobacco materials and tobacco manufacturing equipment, etc. Since November 2006, CTSI had achieved a series of management innovation reforms, including the adoption of information systems Computer Integrated Manufacturing System (CIMS).

After merging and restructuring its original affiliated enterprises, the CTSI Corp. now owns four cigarettes production factories incorporating Jinan, Qingdao, Qingzhou and Tengzhou, and two wholly owned subsidiaries, General Group and Yizhong Group.

**RESEARCH METHODOLOGY**

We conducted a case study to explore the process, features, and drivers of digital manufacturing transformation at CTSI. We used case study in this research because it can offer an extensive and “in-depth” description (Yin, 2013) of digital manufacturing transformation process in China.

The data for this study were gathered through various ways. Besides the first-hand data acquired during field study, the data were collected from various sources, mainly including interviews and discussions with managers, corporate presentation, trade magazines, and other corporate documents.

Our work began with CTSI Corp. in its early digital manufacturing transformation through cooperation between CTSI Corp. and a local university. Supported by the research project, the research design consisted of three field investigations spanned three years, in the spring of 2009, spring of 2010, summer of 2011 in Qingdao Cigarette Factory. In order to update the lasted information, a field study was conducted in December 2014 in Jinan Cigarette Factory.

During the period of investigation, we used interviews with production manager and technicians, and did observations to get the unstructured and semi-structured data. We made a lot of notes during every time visiting workshop.

The subsequent study was conducted based on the interview protocol. The interview protocol developed based on the knowledge from previous literatures (e.g., Harris 1999; Klinenberg 2005; Kolarevic, 2004) and the unique development stage of CTSI. It was designed in English version and then translated to Chinese following standard translation- back-translation procedure. Before the interview, we made discussions with academic experts and subjects experts on IS/IT fields. Their insights were contributed to the interview protocol. After that, based on our research topic, one top manager at technology center in charge of IT deployment, one middle manager in charge of production management in Qingdao Cigarette Factory, and
one marketing manager responsible for marketing in eastern Shandong district were interviewed respectively according to our interview protocol. The same interview protocol was carried out in Qingdao Cigarette Factory.

DIGITAL MANUFACTURING TRANSFORMATION in CTSI

The Process of Digital Manufacturing Transformation

Previous studies have highlighted the role and function of digitalization in different industries. For example, Kohli and Johnson (2011) discussed the digital transformation in oil and natural gas industry by using Encana’s case study. They emphasized that many industries, like oil and natural gas, are latecomers in digitalization. According to their definition, manufacturing industry is also a typical latecomer industry. This study is to provide a better understanding of drivers and challenges for this digital transformation in the context of China state-owned manufacturing industry.

In order to meet the global competition in tobacco industry, CTSI has fulfilled integration of resources and improved internal management mechanism. Digital transformation pushed forward the organizational structure changes. Based on procurement, production, marketing and brand relationships, CTSI enhanced its strength to establish national competitiveness by changing organizational structure. Four centers, Manufacturing Center, Marketing Center, Technology Center and Materials Purchasing Center, were built. Each center is in charge of certain business activities.

In January, 2008, the ERP had been put into practice in CTSI. This is a new milestone for CTSI to build a higher efficiency information management platform. From then on, it achieved a high level of manufacturing digitalization.

After implementing CIMS in CTSI, it brought many effects on its production. For the first year of implementation of CIMS, it was estimated to save 4 million yuan in production cost. Overall speaking, the ability of digitalized design and the ability of innovation management had been greatly improved. The transformation enhanced the whole core technological innovation capability and competiveness.

The major transformation events in CTSI Corp. are listed in Table 1.

<table>
<thead>
<tr>
<th>DATES</th>
<th>MAJOR TRANSFORMATION EVENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar., 2006</td>
<td>Qingdao Cigarette Factory began technical innovation, and the new factory moved from Municipal District to Laoshan District.</td>
</tr>
<tr>
<td>Dec., 2006</td>
<td>CIMS was put into operations in manufacturing production in Qingdao Cigarette Factory.</td>
</tr>
<tr>
<td>Apr., 2007</td>
<td>CIMS was passed “National 863 Program” experts’ appraisal.</td>
</tr>
<tr>
<td>Nov., 2007</td>
<td>Qingdao Cigarette Factory began to implement job performance payment system.</td>
</tr>
<tr>
<td>Jan., 2008</td>
<td>ERP formally was launched through CTSI.</td>
</tr>
<tr>
<td>Dec., 2009</td>
<td>CTSI won the national prize “Leading Six Sigma Quality Management Enterprise”.</td>
</tr>
<tr>
<td>Nov., 2011</td>
<td>Online office platform system began to operate on the Internet.</td>
</tr>
<tr>
<td>Aug., 2013</td>
<td>Cigarette marketing management information systems began to operate on the Internet.</td>
</tr>
<tr>
<td>Mar., 2015</td>
<td>Project management information platform began to operate on the Internet.</td>
</tr>
</tbody>
</table>
Business Strategy and IT Strategy Alignment in CTSI

The overall business strategy goal is to make “Shandong Tobacco revitalization” by brand development. Brand building will be long-term work of CTSI. In the near future, CTSI will try to achieve “3286” strategy plan. 3 means that CTSI will produce a total production over 300 million boxes by 2015; 2 means “Taishan” brand accounts for 200 million boxes by 2015; 8 means the gross commercial wholesale revenue exceeds 80 billion yuan by 2015; 6 means “Taishan” brand accounts for 60 billion yuan by 2015.

The overall IT strategy is to build CTSI as a digitalization-driven enterprise. By its IT strategy, CTSI intends to achieve the following four goals.

- Business management to be informationized
- Production management to be sophisticated
- Product design to be intelligent
- Logistics management to be automated

Even though digital manufacturing contributes to driving CTSI’s development, IS strategy is still considered as the role to support the implementation of business strategy.

Digitalization Infrastructure

It lasted four years, from 2002 to 2006, to finish the National 863 Program. Finally, it built a three-tier CIMS digitalization infrastructure after the transformation.

The upper tier is enterprise resource planning system (ERP). It puts “plan and control” as the main function. By the operations of ERP, it closely connects the management of the customers, marketing, sales, planning, procurement, production, finance, and services. Most information systems are mostly integrated in this tier. It is the supply chain management-oriented modern enterprise management platform and supplemented by cigarettes formula intelligent aided design systems (CAD).

The middle layer is manufacturing execution systems (MES). It can help control the production process, for example, resource scheduling and machines dispatch. The information captured in this layer can help executives improve the decision quality because of the real time production analysis. It is a control layer to carry out lean manufacturing and flexible manufacturing.

The lowest layer is production and logistics automation systems. It is complemented by business intelligence system (BI), office automation system (OA), and computer network support systems etc., to form a comprehensive and advanced information technology support platform. With the help of this tier, it achieves the integration of internal production and external connection, and form a completely digitalized enterprise.

The three tiers together contribute to well achieving CTSI’s IT strategy goals, business management informationized, production management sophisticated, product design to be intelligent, and logistics management automated. On one hand, the CIMS project transforms the management pattern; on the other hand, the new IT-enabled production directly help generate considerable economic profits and save costs. We would discuss its effect in the following section. Figure 4 gives the digitalization infrastructure of CTSI.
FEATURES OF TRANSFORMATION

In order to explore the power of digitalization, we made some comparisons using some indicators in Figure 2, which can help us have a better understanding of features of the change. Because of digital manufacturing transformation, these changes adapting to the new business environment signal the transformation in manufacturing.

In 2006, CIMS was put into operations in production management. We put it as the boundary point and measure the differences of transformation features from external business environment, business strategy and IT strategy, organization structure, equipment, software, the role of production managers and employees, and the skills of managers and technicians.

Based on the interview results and the corporate documents, we arrive at the comparison results.

From the comparison results below, we could find some factors, like external business environment, drive the digital manufacturing transformation. Most of changes are evidently caused by this transformation. We can also notice, because the transformation in manufacturing happened, the production process and even every business operation are produced dramatic changes. Those changes make the enterprise adapt the external business environment more flexible. The business strategy and IT strategy align more closely during this transformation. The company structure also has to make changes because of this transformation. The equipment and software in use are also completely different from its traditional pattern.
### Variables Before Transformation and After Transformation

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>BEFORE TRANSFORMATION</th>
<th>AFTER TRANSFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Business Environment</td>
<td>• Marketing Environment&lt;br&gt;Stable&lt;br&gt;Competitive Environment&lt;br&gt;Less competitive in local market</td>
<td>• Marketing Environment&lt;br&gt;More turbulent and dynamic&lt;br&gt;Competitive Environment&lt;br&gt;Fierce&lt;br&gt;Increasing competition in brand creation</td>
</tr>
<tr>
<td>Business Strategy and IT Strategy</td>
<td>• Business Strategy&lt;br&gt;Concerned more about production and marketing&lt;br&gt;IT Strategy&lt;br&gt;Almost never in consideration</td>
<td>• Business Strategy&lt;br&gt;Get help from IT to achieve business goal&lt;br&gt;IT Strategy&lt;br&gt;Considerable support for business strategy implementation</td>
</tr>
<tr>
<td>Organization Structure</td>
<td>• Corporate structure&lt;br&gt;Pyramid leadership&lt;br&gt;Departmental Set-up&lt;br&gt;Traditional departments setting</td>
<td>• Corporate structure&lt;br&gt;Function-oriented&lt;br&gt;Departmental Set-up&lt;br&gt;New departments emerging more and more as CIMS adopted, especially technology center highlighted</td>
</tr>
<tr>
<td>Equipment</td>
<td>• Production Machines&lt;br&gt;Traditional&lt;br&gt;Office Automation&lt;br&gt;Simple&lt;br&gt;Information Systems Equipment&lt;br&gt;Traditional&lt;br&gt;Hardly any</td>
<td>• Production Machines&lt;br&gt;Automated&lt;br&gt;Intelligent&lt;br&gt;Office Automation&lt;br&gt;Comprehensively use in every business activity&lt;br&gt;Information Systems Equipment&lt;br&gt;CIMS infusion</td>
</tr>
<tr>
<td>Software</td>
<td>Not enough software to support production&lt;br&gt;Paper writing for records</td>
<td>Software for management and control used at each terminal</td>
</tr>
<tr>
<td>The role of managers and employees</td>
<td>Production managers have to spend a lot of time on personnel scheduling</td>
<td>Production managers spend more time on information systems manipulation</td>
</tr>
<tr>
<td>The skills of managers and technicians</td>
<td>• Production Managers Skills&lt;br&gt;Quality control oriented&lt;br&gt;Technicians Skills&lt;br&gt;On physical</td>
<td>• Production Managers Skills&lt;br&gt;IT usage oriented&lt;br&gt;Technicians Skills&lt;br&gt;On information systems usage</td>
</tr>
</tbody>
</table>

### Drivers for Transformation

Although there is an increasing public awareness of health risks in smoking, the tides of cigarette purchase for consumers have not fallen. We try to find the drivers of this...
transformation from different avenues. From the above analysis and interview records, we list the most two important drivers for this transformation.

The first one is that the Chinese Government strongly supports this transformation. In order to respond to the Chinese government's call of "building a resource-conserving and environment-friendly society", the State Tobacco Monopoly Bureau encourages all the tobacco producers to implement technological transformation. In this context, almost each city in China put energy savings and costs reduction as one of the city development objectives. Therefore, the state-owned enterprises determined to make great changes in production pattern by this opportunity. After CTSI put forward the transformation plan, the central government and local government invested heavy money to guarantee the success of the transformation. For example, CTSI built cooperation relationship with many local research institutes, like Ocean University of China in Qingdao, to make the transformation go more effectively.

The second one is that the external business environment drives this transformation. It is acknowledged that China exerts tobacco monopoly policy and all the tobacco producers are under the jurisdiction of China Tobacco. In fact, the internal competition among the producers is also relatively fierce. In order to deal with the customers' need from domestic and abroad, more and more tobacco enterprises produce the products to serve the customers in different areas. After China entered WTO, even more and more foreign brands appear in Chinese market. Because of a small number of high value-added brands, the competitiveness of CTSI is not strong as others. It is not compatible with the economy status of Shandong province. Therefore, CTSI urgently desires to seize the digitalization transformation opportunity to gain competitive advantage by adopting advanced information systems.

CONCLUDING COMMENTS

The study provides insights on digital manufacturing transformation of SOEs in China. From this case study, we can find how state-owned manufacturing enterprises employ the means of digitalization to transform production process in the context of Chinese market. In order to gain competitive advantage, many Chinese state-owned enterprise are in efforts to carry out a more comprehensive digitalization. The findings can provide scholars and practitioners with a better understanding of the features and drivers of this transformation.

REFERENCE


APPENDIX: INTERVIEW PROTOCOL

1. How many stages roughly can be divided for China Tobacco Shandong Industrial (CTSI) in completion of manufacturing digitalization transformation? Could you give a milestone for each stage?

2. What are the main drivers in helping your company to complete manufacturing digitalization transformation?

3. For each stage, please give a simple description about the internal and external organization changes when the manufacturing digitalization transformation occurred.

<table>
<thead>
<tr>
<th>Features of transformation</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>External business environment (E.g. marketing environment, competitive environment, supply chain etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business strategy and IT strategy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(During occurrence of this transformation, whether any change about business and IT strategy happened)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organization structure (E.g. corporate structure, new department emergence and functions change etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment (E.g. production machines, monitoring equipment, office automation equipment and systems etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software for manufacturing digitalization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The role of production managers due to the changes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The skills of managers and technicians (the requirements of skills needed for the changes, including managers and technicians)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. What are the significances of digital manufacturing transformation for China Tobacco Shandong Industrial Corp.? (Including the ability of mass customization, the volume of production, production agility, production flexibility, products quality, unit time for each new product, delivery time to the market etc.)

5. During the transformation, what were the main challenges?

6. In the near future, has China Tobacco Shandong Industrial Corp. schemed new deployment for moving forward to a higher level of manufacturing digitalization?