Motives and Challenges of Open Innovation in Manufacturing Small and Medium-sized Enterprises (SMEs) of China

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Abstract

Since the concept of open innovation was put forward by Chesbrough (2003), many researchers focus on open innovation in large enterprises. There is a research gap in how open innovation is implemented in SMEs, specifically in Chinese companies. The purpose of this thesis is to identify the motives and challenges of manufacturing SMEs in China to implement open innovation.

The study is based on analysis of scientific literature and four case studies of manufacturing SMEs. The empirical data were collected by semi-structure interviews and a survey.

Overall, collaboration with external partners was found to be good for improving innovation performances in the studied companies. And also, four motives were found, which were forming innovation networks, cooperating with external innovation sources, importing advanced technologies, and driving and motivating innovation processes. Meanwhile, four main challenges were found lack of trust in collaboration, disability for transforming external knowledge to internal knowledge, low support from government, and barriers to overcome intellectual property disputes. At last, the authors suggest that manufacturing SMEs in China could collaborate with each other more, and improve the knowledge of intellectual property as well.

Keywords Manufacturing SMEs; Open Innovation; Motives; Challenges
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1. Introduction

1.1 Background

As is well known, innovation can be treated as inexhaustible motivating force for national prosperity. The concept of innovation was introduced by Schumpeter (Schumpeter, 1934). He used five types to describe innovation, which were new products, new methods of production, new sources of supply, the exploitation of new markets, and news ways to organize business.

During most of the 20th century, the paradigm of closed innovation was utilized among most of the enterprises, especially the large and multinational enterprises. Traditionally, closed innovation was identified as the base of keeping enterprises developing. Companies should generate their own ideas, and then develop them, build them, market them, distribute them, service them, finance them, and support them on their own (Chesbrough, 2003). While technology monopoly can cause the high trade barriers, enterprises prefer to building laboratory with enough sources to ensure the monopolistic status in the market (Chesbrough, 2004).

When closed innovation can no longer meet the demands of innovation activities, open innovation appeared. The concept of open innovation was put forward by Chesbrough (2003). In this kind of business model, open innovation utilized both internal and external ideas to create value. It also assumed that internal ideas can be taken to market through external channels, outside the current businesses of the firm, to generate additional value (Chesbrough, 2003).

Open innovation is one of the most important innovation concepts in the management of innovation. Many innovation practices show that, with the constantly development of science and technology, open innovation will bring over expected returns (Chesbrough, 2004). Open innovation makes the status of external innovation and external market as important as internal market. In China, open innovation activities are widely concerned. It influences the competition of enterprises directly, and it contributes to the exploration of development under the age of knowledge economy. Meanwhile, it is an efficient way to coordinate internal and external resources of the enterprises. So the enterprises can get the access to break the bottleneck of technology development (Chen, et al., 2006).

However, most researchers have focus on open innovation in large and multinational enterprises. Only few researchers have studied open innovation in SMEs. Many researchers (Christensen, et al., 1997; Van de Vrande, et al., 2009; Lichtenthaler, 2008; Vahter, et al., 2012) found that SMEs have motivations and advantages to implement open innovation. Market is one of the primary motivations for SMEs. And the improvement of open innovation in SMEs is better than that in large enterprises.

Since the policy of regulation and openness, the market in China has become more and more actively. More and more SMEs in China implement open innovation in their innovation activities (Chen, et al., 2008). While there are few scientific studies on manufacturing SMEs in China, this thesis is interested in the motives and challenges for manufacturing SMEs in China to implement open innovation activities. Because of the gaps in the scientific literatures about open innovation in manufacturing SMEs in China, this thesis is willing to give the better accesses for manufacturing in China to seize motives and overcome the challenges when implement open innovation.
1.2 Purpose and research questions

Research on the implementation of open innovation strategies are increasing. However, the discussions about open innovation in SMEs are lacking. So the purpose of this study is to identify motives and challenges in manufacturing SMEs in China to implement open innovation. The thesis is guided by two research questions.

- What are the motives for manufacturing SMEs in China to implement open innovation?
- What are the challenges for manufacturing SMEs in China in this process?

The empirical study is limited to four case study companies. The ambition is to explore the motives and challenges in these companies rather than drawing conclusions for all SME in China.
2. Methodology

In order to find the answers for research questions, scientific literature review has been done. However, that was not enough. The case study could be another solution for research questions. It would do help to get more information of the situations of manufacturing in China, and that is also good to help solve research questions. During the case study, semi-structured interviews and questionnaire surveys were utilized to collect the information of managers’ attitudes and opinions of open innovation, as well as the data of innovation performances.

2.1 Literature review

The literature review part is mainly focused on the scientific theories about open innovation and SMEs. The sources of scientific theories were internet resources and library.

The internet resources included the internet database of library in University of Gävle, China National Knowledge Infrastructure (CNKI), and some search engine like Google, Google Scholar, and Baidu. From these sources, there are some related scientific articles about open innovation and SMEs. The research status of open innovation in SMEs could be gotten from the literature review. And the related knowledge of open innovation and SMEs could be studied as well.

2.2 Case study and interview

According to Yin (2009), case studies are the preferred method when (a) “how” or “why” questions are being posed, (b) the investigator has little control over events, and (c) the focus is on a contemporary phenomenon within a real-life context. As Yin (2009) mentioned, the selection of case study method depends in large part on the research questions. Case study method is relevant to the demands of extensive and “in-depth” description of some social phenomenon. And it focuses on contemporary events. The research questions of case study are usually about “how” and “why”.

The conduction of case study methods could be presented as “plan-design-prepare-collect-analyze-share”. It means decide to use case study methods due to the research questions, identify the cases and establishes the logic of case study, prepare to collect evidence of case study, collect evidence, analyze the evidence, and report the case study.

In this thesis, the authors want to solve the research questions of what are motives and challenges of manufacturing SMEs in China to implement open innovation. As the authors have little control over such events, and the research questions focus on the contemporary phenomenon, which is open innovation in the manufacturing SMEs in China, in real-life context. So the method of case study has been selected.

Two phases were implemented in the interview part. First, information about specific manufacturing SMEs in China was collected from Internet, magazines, and friends. These specific manufacturing SMEs are located near the authors’ hometown, or they are famous of their open innovation activities. The information was mainly about business activities and strategies. The authors collected the information to see whether the business activities and strategies were related to open innovation. While the information of manufacturing SMEs met the requirements, e-mails were sent to the managers of the case enterprise to book the interview. When the managers agreed to be interviewed, the time was determined and the interview outlines were prepared.
Finally, we chose four enterprises as our cases to implement the interview. According to Yin (2009), the researchers should select the cases which will most likely illuminate the research questions. These cases are selected because (a) they all have experiences of open innovation activities over 3 years, (b) the managers are interested in the research questions and agree to share their opinions and experiences of open innovation activities, (c) the interviews and surveys can be implemented convenient in these enterprises. The case enterprises are Shaoxing Hezhong Fiber Co., Ltd. (SHFC), Zhejiang Chetou Pharmaceutical Co., Ltd. (ZCPC), Mianyang Qishiyuan Co., Ltd. (QSYC), and Zhenjiang Siemens Busbar Trunking Systems Co. Ltd. (ZSB). SHFC is an affiliated spunlace non-woven fabric manufacturing enterprise. Meanwhile, ZCPC is an export-oriented high-tech pharmaceutical enterprise. They both have 300 employees approximately, so they can be determined as medium enterprises (Notice of SME standards, 2003). The other two, QSYC, which is a sensor and monitoring instruments of industrial process manufacturing enterprise, and ZSB, which is a high-tech busbar trunking system manufacturing enterprise, are both manufacturing enterprises with employees less than 300. So these two enterprises can be determined as small enterprises (Notice of SME standards, 2003).

Two of the case enterprises, QSYC and ZSB, were interview through the ways of face-to-face, and the other two case enterprises, SHFC and ZCPC, were interviewed from internet communication tool, which is Tencent QQ. The tool can make the interview look like face-to-face from internet.

The data and information were collected by interview and questionnaire survey. In the second phase, semi-structured interview was utilized to gather the data. Semi-structured interview was selected as the interview methods because it has some advantages and suit for the case study in this thesis. According to Louise & While (1994), semi-structured interviews were selected by two primary considerations. First, they are well suited for the exploration of the perceptions and opinions of respondents regarding complex and sometimes sensitive issues and enable probing for more information and clarification of answers. Second, the varied professional, educational and personal histories of the sample group precluded the use of a standardized interview schedule. In the phase of interviews of manufacturing SMEs in China, some questions like business activities or innovation outcomes are necessary to be answered, and also the questionnaires are needed in the interview. So method of unstructured interview is not available. Meanwhile, the opinions of interviewees are useful, and some in-depth investigation can be implemented during the interview. This allows the interviewees to describe their own opinions or problems to the questions. So the method of structured interview is not available as well.

The interviewees were determined as people in charge of important projects and managers of R&D departments. Due to the problems of time and plans of enterprises, six people in four case enterprises accepted interview. The interviewees include General Manager of QSYC, R&D department manager of ZSB, R&D department manager and market department manager of ZCPC, and R&D department manager and leader of an important collaboration project in SHFC. The interviewees are chosen because they are all experienced in the open innovation business activities in the case enterprises. They know the details of open innovation implementation in their own enterprises, and they all have their own opinions towards open innovation in SMEs. The opinions and attitudes from them can do help to solve the research questions.
Before the interview, the interview outlines were prepared (Appendix 1). Each interview lasted for 25-30 minutes approximately. During the interview, interviewees were not limited to answer the questions. Some questions were gone in depth based on the real situations. The interviews were implemented according to the outlines. Usually the interviewees were asked to introduce their companies. Then they were asked about their conceptions of open innovation. And then they were advised to introduce some successful open innovation activities in their enterprise in details. The details included when and how the activities worked, the problems they met and how they overcame the problems, the final outcomes of activities. Sometimes the interviewees also described the motivation and benefits of the open innovation activities. Some data were also collected during the interview, like the patents, investment in R&D processes. From the interviews, a primary understanding of open innovation status in manufacturing SMEs in China has been established. After the interviews, the questionnaires were sent, and also some misunderstandings were explained.

2.3 Questionnaire survey

As Yin (2009) mentioned, survey research is usually used to solve the research questions of “how”, “what”, “where”, “how many”, the method also focuses on contemporary events. According to Fowler (2009), there are three potential properties of data that may make surveys preferable to data from other sources, which are probability sampling, standardized measurement, and special-purposed survey.

The components of surveys include sampling, question design, interviewing, data collection, and total survey design (Fowler, 2009). If we want to conduct survey research, we could follow the steps as: Implementing a sample design, design questions, evaluate questions, interviewing, collecting data, and analyzing.

In questionnaire survey part, the utilized questionnaire (Appendix 2) is from Professor Lars Bengtsson (professor at Faculty of Engineering and Sustainable Development in University of Gävle). The survey is part of a research project on Open Innovation Approaches in the European Manufacturing Industry conducted in collaboration by Universities from Sweden, Italy, UK, Finland and Spain. The questionnaire statements designed to obtain information on collaboration in innovation with external partners.

The questionnaire includes eight sections, which are:

1. General data of the company. This section includes the name, main economic activity, number of employees, turnover.

2. The opening of the innovation process. This section is mainly judging whether the case company has external partners in innovation activities in recent 5 years.

3. Challenges of collaboration in innovation. This section tries to measure some challenges of collaboration in innovation. The score is from 1 (not important at all) to 7 (extremely important).

4. Openness. This section tries to indicate the extent of stakeholders and phase of innovation process. The score is from 1 (not at all) to 7 (to great extent) and 8 (do not know).
Strategy and drivers. This section tries to indicate the agreement of drivers in innovation activities and statements with respect to the strategy of the case company. The score is from 1 (strongly disagree) to 7 (strongly agree) and 8 (do not know).

Business environment and intellectual property regime. This section tries to measure the agreement of business environment and the extent to intellectual property protection mechanisms. The score is from 1 (not at all/ strongly disagree) to 7 (to great extent/ strongly agree) and 8 (do not know).

Collaboration. This section tries to measure the agreement of organizational and managerial actions, technological staff, and intercommunication skills. The score is from 1 (strongly disagree) to 7 (strongly agree) and 8 (do not know).

Innovation and firm performance. This section tries to indicate how well collaboration with external partners in innovation activities performed. The score is from 1 (not at all) to 7 (to great extent) and 8 (do not know).

These questionnaires were utilized to collect data through e-mails and face-to-face filling. The managers of the case company are asked for help of filling the survey, and they choose some experienced workers to fill the survey. In fact, each enterprise received 21 questionnaires. And fortunately, we got a high rate of response. The experienced workers know more about the open innovation activities in their enterprises, and this can help improve the accuracy and validity of the data.

The previous studies of this thesis show that innovation performances can be another characteristic to find the motives and challenges. According to Cooper & Kleinschmidt (1987) and Chen, et al., (2008), innovation performance can be measured by sales of new products, margins of new products, number of new products, patents, investment in innovation, life circle of new products. In this thesis, five characteristics are used to measure the innovation performances. The characteristics include patents, number of new product, sales of new products, rate of new product sales, and investment rate. The data of innovation performances come from interview, internet, and the public materials in the enterprises.

According to Fowler (2009), there may be some difficulties during the survey research. Like the statements of questions are hard to understand, the respondents are lack of knowledge to answer the questions, the answers could be affected by the attitudes of respondents. We take some actions to overcome the difficulties. As mentioned before, we choose the workers who have worked for the case enterprises over 3 years as the respondents. We think they are experienced to answer the questionnaires. The surveys were done face-to-face at first, and we try our best to explain the confused words. Another two surveys were done through the e-mails. We use tips or change the words to make the statements understandable. In order to improve the accuracy of the data, some unqualified data were abandoned.

At last, the collected data was analyzed. The average data were utilized to measure each statement. The average data was chosen because it can represent the average attitudes of respondents for the questionnaire statements. And during the processing of data, some unqualified data were abandoned. The unqualified data are like all data are same in one questionnaire, or the score has huge gap with others in one statement. And also, when calculating the average data, the score 8 was abandoned, which means “do not know”. After the average data of each statement were calculated, the histograms were built of each section in questionnaire of all the case enterprises. The
histograms can present the gaps between each statement clearly. And comparisons of
data were made according to the histograms. The data came from the questionnaire
surveys which were filled by experienced workers, so the data can present their
attitudes towards open innovation better. The unqualified data were abandoned
because they would influence accuracy of the results. So the final processed data are
qualified. The average data can present the average attitudes to the statements of
questionnaire, and they are useful to know the gaps between each statement.

2.4 Research quality

According to Miller (1986), qualitative research is a sociological and anthropological
tradition of inquiry. The objectivity of a piece of qualitative research is evaluated in
terms of the reliability and validity of its observations.

According to Johnson (1997), validity of qualitative research can be divided into three
types: descriptive validity, interpretive validity, and theoretical validity.

Descriptive validity refers to the factual accuracy of the account as reported by the
researchers. In other words, it refers to accuracy in reporting descriptive information.
For example, the data in this thesis were collected through different resources, such as
interviews, surveys, and Internet.

Interpretive validity refers to accurately portraying the meaning attached by
participants to what is being studied by the researchers. More specifically, it refers to
the degree to which the research participants’ viewpoints, thoughts, feelings,
itentions and experiences are accurately understood by the qualitative researcher and
portrayed in the research port. For example, semi-structured interviews were selected
to take a directly obvious to the attitudes of interviewees towards open innovation.

Theoretical validity usually refers to the degree that a theoretical explanation
developed from a research study fits the data and is credible and defensible. For
example, the data were collected due to the methods of theoretical articles.

As Seale (1999) mentioned, reliability of research can be reflected in the level of
confidence, it can be used to legitimate a degree of difference that nevertheless
allowed them to advocate pragmatic combinations of quantitative and qualitative
work. In this thesis, for example, the data were collected from multiple resources, and
unqualified data were abandoned before analysis.

Therefore, in order to increase the validity of the thesis, some methods were taken.
The reviewed theoretical articles were selected from the different Internet databases
and search engines. The case enterprises were selected through multiple resources,
and the business activities and introductions of the enterprises were considered during
the selection. The data included primary data from the interviews and secondary data
from internet. And the data were collected from semi-structured interviews and
questionnaire surveys. Experienced workers and managers were chosen as
interviewees to increase the validity of data, and the outlines of interviews were
prepared according to the theoretical articles.

Meanwhile, some methods were taken to increase the reliability of this thesis. The
data were collected from multiple resources to increase the objectiveness. And also
the interviews and surveys were implemented through face-to-face. The unqualified
data were abandoned before analysis. The conclusions were made according to
theoretical articles, processed data from questionnaire surveys, and information from
interviews.
3. Theoretical framework

3.1 Innovation background

The research of innovation theory started on early 20th century. Schumpeter, who was a professor of Harvard University, built innovation theory in his book “The theory of economic development” (1934). Innovation can be treated as the initial application of new technology or new invention in production process. It establishes a new factor of production or supply function. It is also a new combination of product factors and conditions in production system. Schumpeter distinguished innovation in five different types: new products, new methods of production, new sources of supply, the exploitation of new markets, and news ways to organize business. He thought that innovation was bringing a new combination of production factors to production system; the perspective of innovation was getting potential profits.

Innovation is not a single action; it is a total process of some interrelated sub-processes. According to Solow (1957), innovation was the total process of theoretical concepts, technical inventions and business exploitation.

From the perspective of business management, technology innovation is a process which begins with generation of new ideas, and then exploration, developing, production and at last end up with commercialization (Chen, et al., 2001). Inventions cannot be called technology innovations without commercialization. Technology innovation should make ideas or inventions get commercial success, the sign of its success is so called “the first commercial of technology inventions”. There is no internal value in technology itself, only implement commercial development through some kinds of business model can dig out its value. (Chesbrough, 2003) The success of technology innovation requires coordination of development, production and market.

3.2 Closed innovation background

During most time of the 20th century, a kind of paradigm which named “closed innovation” brought great success to companies. This paradigm was a view that said successful innovation required control. Companies should generate their own ideas, and then develop them, build them, market them, distribute them, service them, finance them, and support them on their own (Chesbrough, 2003). Closed innovation focused on internal research and develops process mostly, which was treated as most valuable strategic assets of enterprises. It was a strong way to form market barriers to the competitors. Under this situation, some enterprises made significant long-term investments in internal research and developing processes.

In fact, the working process of this kind of paradigm was dependent on increasing investment in research and developing processes. Because of this, the company could achieve fundamental technology breakthroughs, which means the company could manufacture new products and new features. This could help the company lead the market and gain more sales and profits through existing business model. Besides, more investment can be set into the research and develop process. The logic of closed innovation created a virtuous circle (Figure 1).
For most of the 20th century, this paradigm worked well. Many companies built its own research laboratory, such as General Electric’s famed laboratory, or Bell laboratory. As showed in figure 2. In the research and development management with closed innovation paradigm, ideas flow into the enterprises from the left and flow out to the market on the right. After being screened and filtered during the research process, the surviving ideas are transferred into development and then taken to the market.

However, with the rise of knowledgeable economy, professional division, modularize manufacture and network organization, closed innovation could no longer meet the demands of the business activities. For instance, Palo Alto Research Center (PARC), which was established by Xerox Corporation, was famous by inventing many new technologies. It developed numerous valuable computer software and hardware innovations, but Xerox and its shareholders got few profits from them.
According to Chesbrough (2003), there are some reasons for breaking the Virtuous Circle. As it is shown in figure 3. The scientists and engineers who made fundamental technology breakthroughs became more and more flexible. Once the company did not pursue the breakthroughs timely, the scientists and engineers can pursue them on new start-up firms. The rise of venture capital made it possible for the scientists and engineers to take the breakthroughs from laboratory to the market. Some companies may be failed, shown as rest in peace (RIP). But once the companies became successful, it might achieve initial public offering (IPO). Such successful companies may invest in external technology to commercialize.

![Figure 3 Reasons for breaking Virtuous Circle](image)

### 3.3 Openness

Before the creation for the concept of open innovation, many scholars had put forward some ideas within “open”. A lot of evidence that suggests innovation is the key driver of developing and keeping the high yield of companies (Drucker, 1988; Christensen, 1997; Thomke, 2002). Nowadays, the innovation which is limited inside the company has become rarer; it is difficult for the single enterprise to keep positive research on the entire advanced technical field. None of the enterprises with abundant technique strength can create all the knowledge for technology innovation by themselves. It seems impossible for them to acquire all the resources and knowledge they need to implement technology innovation (Teece, 1992; Caloghirou, et al., 2004).

Nelson & Winter (1982) proposed to search new technology outside the organization, while Teece (1992) pointed out the importance of complementary assets for innovation success. He thought that it was necessary for the innovation pioneers, who were lack of complementary assets, to achieve manufacturing capabilities and marketing capabilities from the external process. They could promote the successful commercialization of new products by the process of cooperation and coordination. The core competitiveness of enterprise is increasingly dependent on knowledge exploration, knowledge creation and constant technology innovation (Powell, 1996). The creation of capabilities in new technique fields of enterprise is a dynamic learning process, it needs the access to external technical achievement and internal technical activities.
3.4 Open innovation background

Closed innovation had many advantages during the most time of 20th century. However, this kind of innovation paradigm changed since 1990s. It was surprising that some abandoned ideas became the new influential products in some new start-up enterprises (Chesbrough, 2004). Some reasons can be concluded as below (Yang, 2006):

1. The possibility of mobility of academic engineers was growing. Which means, when the enterprises wanted to control an important innovation process, they might face the problem that the needed engineers were outside the enterprises.

2. The research ability and research quality of the academic institutions were improving, which led to the high capability to implement research project. This had contributed to the development of open innovation. One of the certification was that many research breakthroughs came from universities.

3. The rapid increasing of venture capital made it easy for the enterprises with unique technology to be established. Because of the increased richness and diversity of external resources, the resources for technology market had improved.

4. Economic globalization brought a new phase to innovation. It had made the configuration and flow of new resources working in the larger range.

5. The reduction of production life cycle led to the higher requirements of innovation speed. During the market competition, the successful innovation was not just influenced by innovation quality, the innovation speed was more important. Collaboration internal and external enterprises were necessary for innovation successfully.

6. With the international trend of intellectual property, open innovation could make enterprises benefit from technology transfer. And also when implementing open innovation, the enterprises can combine the quality and quantity of the technology innovation assets.

As it mentioned before, the closed innovation paradigm was no longer adapted to the environment. For these situations, a new kind of paradigm, which was called “open innovation”, was emerging in place of closed innovation. According to Chesbrough (2003), open innovation was “a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology”. This kind of paradigm may be defined as “the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation, respectively” (Chesbrough, et al., 2006).

Open innovation create new ideas through balancing the internal and external resources of the enterprises. Not only focuses on the traditional product management, open innovation also looks for the appropriate external business activities, such as technical permit, technology merger and acquisition, strategic alliances or venture capital. These business activities can realize the innovative ideas and form the industrialization.

Open innovation builds a new way to manage research and develop process. As it is shown in figure 4, it achieves valuable ideas from both internal and external enterprise
and it can promote internal innovation with internal and external valuable knowledge as well as expand market with external innovation (Chesbrough, 2006). Meanwhile, Chen, et al., (2006) thought that in the open innovation process, suppliers and lead-users were also the important sources and participants of technological innovation.

Figure 4 Open Innovation Paradigm for managing R&D (Chen, et al., 2006)

According to Chesbrough (2003), a table had been made to compare the differences between closed innovation paradigm and open innovation paradigm (Table 1).

Table 1 Comparison between closed innovation and open innovation

<table>
<thead>
<tr>
<th>Closed Innovation Principles</th>
<th>Open Innovation Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>The smart people in our field work for us.</td>
<td>Not all the smart people work for us. We need to work with smart people inside and outside our company.</td>
</tr>
<tr>
<td>To profit from R&amp;D, we must discover it, develop it, and ship it ourselves.</td>
<td>External R&amp;D can create significant value; internal R&amp;D is needed to claim some portion of that value.</td>
</tr>
<tr>
<td>If we discover it ourselves, we will get it to market first.</td>
<td>We don’t have to originate the research to profit from it.</td>
</tr>
<tr>
<td>The company that gets an innovation to market first will win.</td>
<td>Building a better business model is better than getting to market first.</td>
</tr>
<tr>
<td>If we create the most and the best ideas in the industry, we will win.</td>
<td>If we make the best use of internal and external ideas, we will win.</td>
</tr>
<tr>
<td>We should control our IP, so that our competitors don’t profit from our ideas.</td>
<td>We should profit from others’ use of our IP, and we should buy others’ IP whenever it advances our own business model.</td>
</tr>
</tbody>
</table>

Open innovation plays the important parts in many fields. Many researchers have showed interests on the relationship between open innovation and enterprise
innovation performance. Some kinds of external collaborating business activities were researched, such as research outsourcing (Chen, et al., 2009), innovation network (Freeman, 1991), innovation collaboration (Luo & Tang, 2001), and collaboration with universities and academic institutions (Veugelers, et al., 2005). Despite the negative effects like the leakage risk of technical knowledge, increasing dependence of external technology, and increasing cost of coordination (Lee, et al., 2010), open innovation management is generally helpful to increase the innovation performance. Meanwhile, some researches think that improve the relationships between enterprises and external organizations can contribute to improve the innovation performances. The external organizations include customers, universities and academic institutions, technological intermediary, public institutions (Chen, et al., 2008).

According to Rigby & Zook (2002), while under the open innovation environment, enterprises can strengthen the innovative foundation through introducing the external ideas and technology. Ozman (2008) described the positive role of open innovation to innovation performance from two aspects: network externalities and learning. While studied the case of transformation of the consumer electronics industry, Christensen, et al., (2005) discussed the influence to the innovation performance with different opening models. Meanwhile, Chen & Wang (2011) studied selective open innovation through the case of EPA innovation project of Supcon.

As the result of many researches, during the process of open innovation, enterprises need to choose appropriate opening objects. This is because the difference of the innovation process. In the basic research phase, the opening objects of enterprises should be more focused on universities or related scientific research institutes. While in the application development and improvement phase, the objects should be changed to related enterprises and customers. And in the international competition phase, enterprises should strengthen the collaboration with the government.

### 3.5 Small and medium-sized enterprises

Small and medium-sized enterprises (SMEs) are defined differently in different countries, different fields and in different economic phase. Generally, SMEs are defined according to two aspects, which are quality and quantity. The former mainly includes organizational form, way of financing, and the industry status. The latter mainly includes the number of employees, paid-in capital, and total assets. Most countries use quantity to define SMEs because of its visual indicator easy to measure.

In China, the government has published the standard about SMEs. The standard was put forward according to the number of employees, total assets and sales. Table 2 shows the standards of enterprises’ scales in China (Notice of SME standards, 2003).

<table>
<thead>
<tr>
<th>Industry</th>
<th>Index</th>
<th>Unit</th>
<th>Large</th>
<th>Medium</th>
<th>Small</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacture</td>
<td>Employees</td>
<td>Person</td>
<td>&gt;2000</td>
<td>300-2000</td>
<td>&lt;300</td>
</tr>
<tr>
<td></td>
<td>Sales</td>
<td>Million SEK</td>
<td>&gt;30000</td>
<td>3000-30000</td>
<td>&lt;3000</td>
</tr>
<tr>
<td></td>
<td>Total assets</td>
<td>Million SEK</td>
<td>&gt;40000</td>
<td>4000-40000</td>
<td>&lt;4000</td>
</tr>
<tr>
<td>Architecture</td>
<td>Employees</td>
<td>Person</td>
<td>&gt;3000</td>
<td>600-3000</td>
<td>&lt;600</td>
</tr>
<tr>
<td></td>
<td>Sales</td>
<td>Million SEK</td>
<td>&gt;30000</td>
<td>3000-30000</td>
<td>&lt;3000</td>
</tr>
</tbody>
</table>
In this thesis, manufacturing SMEs were defined as the enterprises which have employees less than 500.

Some researchers have showed that SMEs were the most active group in innovation activities. Many high-tech innovations are worked out by SMEs. According to Liu, et al. (2003), the outputs of research by SMEs were 3.5 times more than large enterprises per unit of inputs. In Germany, 2/3 of the patents were developed and applied by SMEs. While in China, 65% of the invention patents, 75% of the technology innovation and 80% of the new products were worked out by SMEs (Yang, 2004).

Because of the simple management and decision making mechanism, the cost of internal transaction of enterprises can be reduced. According to Rothwell & Zegveld (1985), SMEs had some advantages in technology innovation because of its management. Compared with SMEs, the management and decision making mechanism of large enterprises are more complex, which leads to the conservative management. This kind of bureaucratism is easy to cause the increasing of the organization cost and the inertia of decision making mechanism. The large enterprises are not as flexible as SMEs to adapt to the change of the market.

However, the loose management environment and organization structure make it easy for SMEs’ employees to communicate with each other. The organizations in SMEs can be more cohesive. These are the reasons for the better innovation capability of SMEs. While the demands of market and customers changed, SMEs can make their decision quickly. Table 3 shows the advantages and disadvantages in innovation between SMEs and large companies.

Table 3 Differences of innovation between SMEs and large enterprises. (Rothwell & Zegveld, 1985)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>SMEs</th>
<th>Large enterprises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marketing</td>
<td>Capability to adapt to the rapid demands of the changing market. (They may face high prohibitive cost in the sales of innovative</td>
<td>Comprehensive distribution and service facilities; High market share in current market</td>
</tr>
<tr>
<td>Category</td>
<td>Description</td>
<td>Example</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Management</td>
<td>No bureaucratism; Dynamic entrepreneurial managers are able to react quickly to take advantage of new motives and willing to take risks. Professional managers are able to control the complex organization and develop corporate strategy. (Company will be victimized due to excessive bureaucratic; Managers may become merely an administrative officer, who will be lack of motivation to the new long-term motives)</td>
<td></td>
</tr>
<tr>
<td>Internal communication</td>
<td>Effective and informal internal communication network; Be able to respond quickly to solve the internal problems; Be able to identify and adapt to external changes quickly. External communication is often too cumbersome; which may lead to a very slow reaction to the external threats and motives.</td>
<td></td>
</tr>
<tr>
<td>Qualified technical human resources</td>
<td>Be lack of qualified technical experts; Cannot support the research and development of considerable size. The ability to attract highly skilled technical experts; Be able to support the establishment of a large-scale research laboratory.</td>
<td></td>
</tr>
<tr>
<td>External communication</td>
<td>Lack of time and resources to take advantage of important external science and technology. Be able to attract the important external science and technology; Be able to pay for libraries and experimental style service; Be able to outsource the R&amp;D process to specialized research centers; Be able to purchase the important technical knowledge and technology.</td>
<td></td>
</tr>
<tr>
<td>Finance</td>
<td>Be difficult to attract venture capital; Innovation may mean the disproportionately large risks; Risks cannot be dispersed into a series of projects. Be able to borrow capital from the capital markets; Be able to disperse risks into a series of projects; Be able to finance the diversification of the new technologies and new market</td>
<td></td>
</tr>
<tr>
<td>Economies of scale and systematic approach</td>
<td>In some fields economies of scale become the important entry barriers of small businesses; Cannot provide the integrated production line or system. Be able to achieve economies of scale from R&amp;D, production and retailer; Be able to provide a series of complementary products; Be able to tender to large-scale projects</td>
<td></td>
</tr>
<tr>
<td>Growth</td>
<td>May face difficulties in access of rapid growth of necessary external capital; Sometimes managers cannot cope with the increasingly complex organizations. Be able to provide financial support to expand the productive base; Be able to finance the growth by variety of mergers</td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td>May meet problems when processing system models; Cannot afford the time and cost burdens in patent litigation. Be able to hire patent experts; Be able to afford the time and cost to protect patents.</td>
<td></td>
</tr>
<tr>
<td>Government regulation</td>
<td>Unable to cope with the complex rules and regulations; Bear the high unit cost to obey regulation. Be able to pay for legal services to deal with complex issues of control rules; Be able to decentralize regulatory costs; Be able to finance the necessary R&amp;D to obey regulation</td>
<td></td>
</tr>
</tbody>
</table>

Even SMEs have many advantages in technology innovation, most articles of open innovation focused on the high-tech multinational enterprises, only a few researchers discussed the innovation models in SMEs. In the research of Christensen, et al.,
(2005), the choice of open innovation paradigm mainly considered the level of the technology, and also the status of innovation systems as well as choice of value. At the beginning of the technology, the necessary assets include innovation assets and related operation assets. For SMEs, the challenges of this stage are how to build the profound foundation of technology and how to attract the complementary members (manufacturer, retailer) with efficient communication. In the research of Van de Vrande, et al., (2009), they studied 605 innovative SMEs in Netherlands from the database and concluded that open innovation was widely used in SMEs. What is more, the open innovation in SMEs became more powerful. They thought that the motivation of the open innovation in SMEs was market driven. The challenges of SMEs in open innovation are the differences between achievement of external resources and organizational culture. During the survey of SMEs in Germany, Australia and Switzerland, Lichtenthaler (2008) found that 32.5% of the enterprises implemented open innovation. Lee, et al., (2010) used intermediated network model to research the open innovation in SMEs, and they found that open innovation worked well in SMEs. It is an efficient access for SMEs to promote open innovation by related network. The market is considered as an important factor of successful innovation and successful innovation means successful commercialization. So SMEs can benefit in the commercial phase. Vahter, et al., (2012) pointed out that SMEs can benefit more with innovative openness. When compared the effects of innovation performance with the influence by openness, SMEs plays better than large enterprises. However, because of the huge gap in the level of openness between SMEs and large enterprises, the open innovation in SMEs is ignored by large companies.

The utilization of external technology can avoid high cost of internal development. It can also get the advantages of fast improvement and being closed to the frontier technology. However, the reality is not optimistic in China. Even China has implemented several large-scale importation of technology since the policy of reform and openness; the local enterprises have not achieved the high level of the technology capability. Instead, many SMEs are trapped in the vicious circle of “importation-fall behind- importation-fall behind". This means, the enterprises import the advanced technologies, but cannot transform the technologies to their own, they waste money and fell behind. And they want to improve their performances and just know importation can do help. So they waste money to import technologies twice and fell behind again. The strategy of “exchanging technology with market” has not worked well (Chen, et al., 2006). Some enterprises are serious lack of innovation capability in the core and key technology. This results the severe asymmetry in the manufacturing capability and technology capability of China. So the exploration of the innovation strategy has been implemented.

Meanwhile, since the policy of reform and openness of China, SMEs in China have grown rapidly. They have become the important parts of socialist market economy. According to the survey by National Development and Reform Commission of China (Status of SMEs in China, 2008), up to the end of 2008, the number of registered SMEs in China is more than 420 million, which contains more than 99.4% of the total enterprises in China. The industrial output and tax of SMEs makes up 60% and 40%. SMEs contain 90% of retail outlets in circulation areas. And they provide about 75% motives of employment. They also contribute 60% to the total exports of China.

SMEs have some unique advantages in technology innovation. Generally, the managers of SMEs have consciousness of innovation. They are always good at some
fields, and some SMEs are set based on their technical expertise. When meeting the changing environment, the managers of SMEs can be innovative. Additionally, SMEs have less bureaucratism. Since the innovation process needs the coordinate communication among different departments, less bureaucratism makes it easy for SMEs to make decision. Meanwhile, the market are changing rapidly, because of the strong adaptability, SMEs can adjust their countermeasures quickly.

However, when compared with large enterprises or multinational enterprises, the level of technology innovation in SMEs of China is low. There are huge gaps in innovation investment, research capability and achievements transformation. These have become the bottleneck of the innovation development of SMEs.

According to the research (Status of SMEs in China, 2008), the low capability of innovation in SMEs of China is influence by some aspects as below:

(1) The ability of research and development process is weak in SMEs. SMEs are lack of technology innovators. According to the statistic, enterprises have 60% researchers of the total; however, most of them are in large enterprises. The average academic level of employees in SMEs cannot even reach the national level. The lack of researchers and low education level limit the capability of technology innovation.

(2) Lack of innovation investment in SMEs. The rate of research investment can be a measurement of innovation ability. The investment in developed countries makes up about 2.5%-3% of GDP. However, China has only 1.34%. Lack of innovation investment makes it difficult for SMEs to implement innovation.

(3) Lack of the information of new technology and new production. Information can be one of the most important sources of innovation, but ways for SMEs to achieve information are not rich, which influence the technology innovation in SMEs directly. In order to help SMEs get information, developed countries build information infrastructure as well as specialized information departments. But in China, it is difficult for SMEs to get information. One reason is that the intermediaries to provide information are still in beginning stage, and SMEs cannot build the access to get information independently. The other is the backward of information infrastructure in China. There are few information departments to provide service to SMEs.

(4) SMEs cannot utilize the external resources efficiently. Due to the conditions of low research ability and lack of information, many SMEs use the technology of importation. This is one of the typical performances in open innovation. However, most SMEs only know importation, but do not realize the digestive absorption and imitative innovation after importation. On the other hand, lack of mature management and marketing relationship makes it difficult for SMEs to have collaboration relationship with external enterprises.

SMEs in China are not doing well in research ability, information achievement and external resources utilization. If SMEs want to have further development, technology innovation and core competence should be improved. Meanwhile, when implementing open innovation, if SMEs want to keep improving, they may meet many motives and challenges.

From above, SMEs plays an important part in the improvement of economy. Limited by the lack of internal resources and technologies, SMEs are more likely to search the
external innovation sources. While more and more enterprises change their innovation paradigm from closed innovation to open innovation, SMEs have more motives to improve their innovation capabilities. However, they will also meet many challenges because of their innate shortcomings.
4. Description

In this section, the authors will present the information and data of the case companies. Four case companies will be introduced and the data of interviews and surveys will be presented. The information of case companies introduced below comes from interviews and Internet.

4.1 Case company A: SHFC

Shaoxing Hezhong Fiber Co., Ltd. (SHFC), an affiliated spunlace non-woven fabric manufacturing enterprise of New Transit Group Inc, is one of high-tech enterprise of Zhejiang Province in China. It was founded on April, 2003. And the registered capital of SHFC is about 1 billion SEK. SHFC has 201 employees now and the number of engineering and technical managers whose education backgrounds are higher than bachelor degree is about 50. The enterprise has imported advanced spunlacing lines from Germany and France. It now has strong technology and scientific management, and its productivity of a year is over 30000 ton. With the most advanced equipments and the highest degree of automation, SHFC becomes one of the biggest manufacturing bases of spunlace non-woven fabric in China. The performances of the production are breathable, soft, lightweight, non-toxic, antibacterial and environmental protection. And they have been spread to more than 10 categories and hundreds of varieties. The production types of SHFC include synthetic leather (garment leather substrate materials, ball leather substrate materials, shoes substrate materials), new generation of medical protective materials (surgical gowns, protective clothing), mesh and plain sanitary materials (mask towels, wet wipes, towel roll, gauze), microfiber cleaning cloth (eye rags, instrument rags), filter material and upholstery. The enterprise is one of the high-tech SMEs and patent model enterprises of Zhejiang Province in China (Introduction of SHFC, 2013).

The enterprise has three advanced spunlacing lines imported from famous companies such as Fleissener, NSC, and DILO. Meanwhile, it has established the non-woven technical development center with Donghua University. Professional products of spunlacing non-woven supplied by our company include viscose fiber, bamboo fiber, PET, chitosan fiber non-woven. The products with the weight ranging from 30 to 150 gram per square meter have been applied to many fields such as artificial leather base, medical materials, cleaning materials, automobile decorating and so on. Now their products are sold to South Korea, Japan, Taiwan, America and Europe.

With the WTO accession and global economic integration, the enterprise put forward the philosophies of values trusted, technological development, quality and efficient management. It explores the international market and participates in international competition actively, and establishes the rapid response mechanisms of small volume, huge variety, fast delivery and high quality. It has passed the acceptance check as selected company to keep clean producing launched by economic and trade commission and environmental protection department of Zhejiang province at the end of 2005, which has also got the certificate of ISO14001 and ISO9001.

In 2003, in order to adjust the industrial structure and develop new economic growth points, SHFC invested 1.5 billion SEK to import advanced spunlace non-woven production lines from Germany and France. The production line is the first production instrument with the technologies of cross-draft network and compound coacervation fiber in China. It has the advantages of high technology, advanced automation, widely
suitability. Because of the profits brought by this production line, SHFC imported another two production lines with 1 billion SEK of each in 2006 and 2007.

In recent years, SHFC has paid great attentions to the research and development of new productions. The investment of R&D makes up 5%-7% to the total sales every year. And this brings the growth of profits to the enterprise. The market share of SHFC is over 15% in China.

SHFC has built some external collaboration relationships with some global famous brands like Kimberly-Clark, Johnson & Johnson and Hengan. By Kimberly case, SHFC built relationships with Kimberly in 2004, but Kimberly did not make orders at first. It asked for some requirements, and cooperated in the development of filter materials and spunlace. Until August of 2010, SHFC achieved most of the requirements, and the order of Kimberly is 300 ton per month. SHFC will develop the productions based on the requirements of customers. Sometimes the customers may provide some samples and give some theoretical ideas. And the enterprise will develop the production based on these requirements.

SHFC has established the non-woven technical development center with Donghua University. The technological cooperation is working in instrument choice, product positioning, staff training and new product development. After the improvement of 5 years, SHFC has become the leader of the field of spunlace non-woven fiber. SHFC and Donghua University have overcome many technological projects, and some of them have been rewarded, such as “new material of biodegradable medical spunlace nonwoven” and “application of functional cellulose fiber products”.

4.2 Case company B: ZCPC

Zhejiang Chetou Pharmaceutical Co., Ltd. (ZCPC) was founded in 1988. It is an export-oriented high-tech pharmaceutical enterprise which includes research, development, manufacture, operation and service. It owns the rights of importation and exportation. The registered capital of ZCPC is 60 million SEK. Now ZCPC has about 300 employees, includes more than 70 technological experts (Introduction of ZCPC, 2013).

The productions of ZCPC are mainly about series of nucleoside antiviral, series of anti-inflammatory. ZCPC is one of the biggest manufacture enterprises to produce the raw materials of naproxen and acyclovir. Most of the productions are exported to European and Southeast Asia.

ZCPC has established a good quality assurance system. Its main productions have got the certifications of American Food and Drug Administration (FDA) and European Certificate of Suitability (COS). And all of its productions have got the certificate of Good Manufacturing Practice (GMP). In 2004, ZCPC passed the certification of ISO9001, ISO14001 and OHSAS18001. It is learning the social responsibility of SA8000 to make the management more normal.

The sales assets of ZCPC are more than 2.4 billion SEK at the end of 2012 with over 25 million USD from exportation. The investment of R&D is about 5.5%-6% to the total sales every year.

ZCPC has built many cooperation relationships to some universities and research institutions. Many of its employees are from Zhejiang University, East China University of Science and Technology, Sichuan University and Lanzhou University. In 2001, ZCPC offered master degree of engineering courses with East China
University of Science and Technology. The enterprise wanted the employees to contact the theories to the reality and learn the theories of chemical pharmacy systematically. The courses can help the employees broaden the mind and update the knowledge. In 2002, ZCPC invested with Shanghai Pharmaceutical Industry Institute to build a research center of pharmaceutical technology, they have found many new products in this research center. And also ZCPC implemented a lot of pharmaceutical projects with Zhejiang University; the projects help ZCPC become innovative.

Meanwhile, ZCPC has built some collaboration relationships with competitors. It has implemented a project of improving a kind of intermediates with another pharmaceutical manufacturing enterprise, and finally the project was finished successfully.

4.3 Case company C: QSYC

Mianyang Qishiyuan Co., Ltd. (QSYC) was founded in 2003. The registered capital of the enterprise is 1 million SEK. It only has 41 employees, but the turnover of QSYC has grown over 150 million SEK at the end of 2011.

The business of QSYC is mainly about the development and manufacture of sensor and monitoring instruments of industrial process. The enterprise keeps following the develop trends of measurement and control technology. It imported advanced technology from abroad and made the technology utilized. It has put forward many new necessary productions with its own intellectual property. The productions include projectile shock pressure sensor QSY8116, engine-specific detection sensor QSY8104, low-power wide temperature geological condition monitoring system QSY200, and intelligent monitoring system of high-speed cold heading machine (Introduction of QSYC, 2013).

In recent years, QSYC has established five series of productions with proprietary intellectual property. Its productions are utilized in the fields of military industry, engine, civil engineering, and industrial process monitoring.

QSYC owns the group spirit of “Collaboration and Innovation”. It has established high standards to improve the internal management and R&D process. It has got the certification of measurement equipment production license in 2003 and the certification of ISO9001 in 2004.

Since the beginning of the enterprise, QSYC paid attention to building external collaboration relationships with universities and academic research institutions. It has established long-term cooperation relationships with Qinghua University, National University of Defense Technology, China Academy of Engineering Physics, and the 202 department of Weapons Industry.

In 2005, QSYC imported a series of sensors and monitoring instruments from Germany. However, the enterprise did not just import the instruments and sell them. The engineers of QSYC tested the instruments and learned many advanced technologies from the instruments. Because of this, QSYC developed a series of pressure sensors with high quality.

Although QSYC has only 41 employees, it is full of innovativeness. It has its own R&D center and the investment of R&D even makes up about 8%-10% of the total sales. It searches external resources actively to develop and improve its productions. It also keeps cooperating with universities and research institutions to look for new ideas.
4.4 Case company D: ZSB

Zhenjiang Siemens Busbar Trunking Systems Co. Ltd. (ZSB) formerly known as Zhenjiang Klockner-Moeller Busbar Trunking Systems Co. Ltd. (ZMB) in 1998. It was a joint venture between two companies, the German Admiralty-Moeller Company and Jiangsu Changjiang Electrical Group (now known as Daqo Group). Since 2004, Siemens Ltd., China bought the stake from German Admiralty-Moeller Company, ZMB changed its name to ZSB.

ZSB has been fully certified with ISO9001, ISO14001 and OHSAS18001 quality management systems. As a member of the China National Busbar Standardization Committee, ZSB has achieved more ten key patents in busbar industry and has been awarded and recognized as a High-Tech Enterprises and the Model Foreign Investment Enterprise. The full product portfolio of ZSB have not only been certified with CCC certifications, but also passed strictest laboratory tests performed in many countries. Meanwhile, the advanced internal process management systems such as 6S, Siemens Starpower Factory Program and TIEIS managing software jointly developed with Tsinghua University ensures a high efficient operation within the factory (Introduction of ZSB, 2013).

To date, ZSB Products are widely used in the construction business, transportation, electronic industry, automobile industry, many domains such as alcohol, tobacco, engineering, and the city landmarks. It successively participated in the Beijing Tiananmen Square, the Great Hall of the People, the state ministry of foreign affairs, the China Central Television Headquarters, the National Grand Theater, the Kremlin and other major construction projects.

4.5 Results of questionnaire survey and interviews

Some descriptions of the four case companies have been made. During the interview of the case companies, the questionnaires were sent to ask for the survey. 21 questionnaires were sent to each case enterprise. There are 84 questionnaires to the case companies and 76 questionnaires back. Some unqualified questionnaires were abandoned and finally realized that 70 questionnaires are available. The respondent rate is 83.3%. The table 4 below shows some basic information of the case companies.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Case A</th>
<th>Case B</th>
<th>Case C</th>
<th>Case D</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of employees</td>
<td>201</td>
<td>300</td>
<td>41</td>
<td>400</td>
</tr>
<tr>
<td>Founded year</td>
<td>2003</td>
<td>1988</td>
<td>2003</td>
<td>2004</td>
</tr>
<tr>
<td>Turnover in 2012</td>
<td>4.4</td>
<td>2.6</td>
<td>0.2</td>
<td>1.7</td>
</tr>
<tr>
<td>(billion SEK)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td>Manufacturing Industry</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In order to get some reliable and valid data, the respondents must to have work experience over 3 years in the case enterprise. Table 5 shows some information of the respondents.
Table 5 Information of respondents

<table>
<thead>
<tr>
<th></th>
<th>Case A</th>
<th>Case B</th>
<th>Case C</th>
<th>Case D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Male</td>
<td>11</td>
<td>9</td>
<td>14</td>
<td>11</td>
<td>45</td>
</tr>
<tr>
<td>No. of Female</td>
<td>6</td>
<td>7</td>
<td>4</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>Rate of Male</td>
<td>64.7%</td>
<td>56.3%</td>
<td>77.8%</td>
<td>66.7%</td>
<td>64.3%</td>
</tr>
<tr>
<td>Rate of Female</td>
<td>35.3%</td>
<td>43.7%</td>
<td>22.2%</td>
<td>33.3%</td>
<td>35.7%</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>16</td>
<td>18</td>
<td>19</td>
<td>70</td>
</tr>
</tbody>
</table>

Mentioned in methodology part, five characteristics were used to measure the innovation outcomes. The characteristics include patents, number of new product, sales of new products and investment rate. During the interview, the information of these characteristics was from 2009 to 2012. Table 6 shows the information of these four characteristics.

Table 6 Information of innovation outcomes

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>New products number</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case A</td>
<td>15</td>
<td>14</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>Case B</td>
<td>19</td>
<td>16</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>Case C</td>
<td>8</td>
<td>11</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Case D</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Patents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case A</td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Case B</td>
<td>5</td>
<td>7</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Case C</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Case D</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Investment rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case A</td>
<td>5%</td>
<td>5%</td>
<td>6.5%</td>
<td>7%</td>
</tr>
<tr>
<td>Case B</td>
<td>5%</td>
<td>5.5%</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td>Case C</td>
<td>8%</td>
<td>9%</td>
<td>9%</td>
<td>10%</td>
</tr>
<tr>
<td>Case D</td>
<td>4%</td>
<td>4%</td>
<td>6%</td>
<td>7%</td>
</tr>
<tr>
<td>Sales (million SEK)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case A</td>
<td>381</td>
<td>405</td>
<td>422</td>
<td>452</td>
</tr>
<tr>
<td>Case B</td>
<td>284</td>
<td>305</td>
<td>318</td>
<td>331</td>
</tr>
<tr>
<td>Case C</td>
<td>33</td>
<td>35</td>
<td>36</td>
<td>39</td>
</tr>
<tr>
<td>Case D</td>
<td>13</td>
<td>17</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Rate of sales</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case A</td>
<td>10.7%</td>
<td>12.4%</td>
<td>12.9%</td>
<td>15.1%</td>
</tr>
<tr>
<td>Case B</td>
<td>11.4%</td>
<td>15.6%</td>
<td>14.9%</td>
<td>16.8%</td>
</tr>
<tr>
<td>Case C</td>
<td>12.1%</td>
<td>13.4%</td>
<td>14.8%</td>
<td>15.3%</td>
</tr>
</tbody>
</table>
During the survey, the questionnaire was used to collect data. The unqualified questionnaires were abandoned, and the valid data from qualified questionnaires was entered to Microsoft Excel, then the average score of each statement were calculated.

During the interviews, the interviewees explained their attitudes towards open innovation. Table 7 shows some keywords from the case enterprises.

**Table 7 Keywords of case companies’ attitudes towards open innovation**

<table>
<thead>
<tr>
<th>Case companies</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHFC</td>
<td>Convenient importation; various competition; different types of collaboration</td>
</tr>
<tr>
<td>ZCPC</td>
<td>Lots of information accesses; motivation for innovation activities</td>
</tr>
<tr>
<td>QSYC</td>
<td>Close relationships with external partners; more external communications</td>
</tr>
<tr>
<td>ZSB</td>
<td>More ways for cooperation; good way to improve performances</td>
</tr>
</tbody>
</table>

During the interviews, the interviewees also provided some problems they knew or they had met. Table 8 presents some keywords of these problems.

**Table 8 Keywords of problems provided by the case companies**

<table>
<thead>
<tr>
<th>Case companies</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHFC</td>
<td>Low support by government; importation blindly</td>
</tr>
<tr>
<td>ZCPC</td>
<td>Lack of trust</td>
</tr>
<tr>
<td>QSYC</td>
<td>Intellectual property dispute; Lack of human resources</td>
</tr>
<tr>
<td>ZSB</td>
<td>Need more motivation for innovation</td>
</tr>
</tbody>
</table>
The case enterprises indicate the extents of stakeholders in their business activities according to the surveys, as shown in figure 5. And also, the interviewees give their ideas about the most important stakeholders to their open innovation activities. The results can be found in table 9.

![Figure 5 Stakeholders in innovation activities](image)

Table 9 Main collaboration partners about case enterprises

<table>
<thead>
<tr>
<th>Statement</th>
<th>Case A</th>
<th>Case B</th>
<th>Case C</th>
<th>Case D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Universities and research centers</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>2. Innovation intermediaries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Government agencies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Customers (i.e. retailers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Suppliers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Consumers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Competitors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Companies operating in other industries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Table 9 Main collaboration partners about case enterprises](image)
The figure below shows the experience of case enterprises in collaboration in open innovation activities.

Figure 6 Experience in collaboration with external partners

<table>
<thead>
<tr>
<th>Number</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>We share a similar management style with our partners</td>
</tr>
<tr>
<td>2</td>
<td>There is a mutual interest in working collaboratively among partners</td>
</tr>
<tr>
<td>3</td>
<td>There is a high level of trust among partners</td>
</tr>
<tr>
<td>4</td>
<td>Partners’ technological competences match up</td>
</tr>
<tr>
<td>5</td>
<td>Access to partners’ knowledge resources</td>
</tr>
<tr>
<td>6</td>
<td>Synergy created by combining knowledge among participating firms</td>
</tr>
</tbody>
</table>

Figure 7 Phases in collaboration with external partners

Figure 7 shows the phases of case enterprises in collaboration with external partners.

<table>
<thead>
<tr>
<th>Number</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Idea generation/exploration research</td>
</tr>
<tr>
<td>2</td>
<td>Experimentation</td>
</tr>
<tr>
<td>3</td>
<td>Engineering</td>
</tr>
<tr>
<td>4</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>5</td>
<td>Commercialization</td>
</tr>
</tbody>
</table>
The figure below presents the extents of intellectual property protection mechanisms in collaboration with external partners of case enterprises.

![Figure 8 Intellectual property protection mechanisms in collaboration with external partners](image)

The figure below presents the performances in collaboration with external partners.

![Figure 9 Performances in collaboration with external partners](image)
5. Analysis and discussion

5.1 Characteristics to improve innovation performances

Even though closed innovation paradigm brought great business success to the enterprises, it is no longer suitable for enterprises now. Since the concept of open innovation was put forward by Chesbrough (2003), more and more researchers have been interested in open innovation. However, most researches focus on high-tech multinational enterprises, only few research objects are SMEs. Especially, there is not even an integrated systematic theory of open innovation in SMEs in China. From table 6, it can be seen that the investments in R&D processes of case enterprises are increasing, and the sales are also increasing. However, manufacturing SMEs cannot afford to improve innovation performances just by increasing investment in R&D. They have to find other ways, and open innovation provides new choices. According to Chen, et al., (2008), improve the relationships between enterprises and external organizations can contribute to improve the innovation performances. The external organizations include customers, universities and academic institutions, technological intermediary, public institutions. Figure 5 is about the stakeholders in innovation activities by the case enterprises. In order to find the most useful partners of case enterprises, we list the partners mentioned by interviewees in table 9. Finally some characteristics were found to help open innovation improve the innovative performances of manufacturing SMEs in China.

Figure 5 shows the common attitudes towards the stakeholders. In fact, during the interviews, the managers provided their main collaboration partners among these characteristics, as table 9 shows below.

From table 9, it can be found that five characteristics were mentioned by all the case companies. They are universities, government agencies, customers, suppliers, and competitors. So the authors thought that establishing collaboration relationships with these characteristics could be helpful for manufacturing SMEs in China to improve their innovation performances.

5.1.1 Collaboration with customers

Nowadays, buyers’ market becomes predominate. The enterprises should understand the demands of customers more than customers themselves. In order to do so, enterprises should let the customers join the development process of products or services.

According to Rothwell & Zegveld (1985), user-oriented issues are the key factors to successful innovation. If the enterprises listen to the demands of customers during the develop process of new product, they may develop more advanced products. Collaboration with customers is very important for enterprises to keep or improve competitiveness. Customers can be sources of innovation to the enterprises. Enterprises can get some useful and valuable information from customers, even the ideas to create new products.

Customers become more and more important in innovation process. To the traditional points, new products are only developed by the manufactures. However, more and more people realize that the roles of customers have changed from passiveness to
activeness. Meeting the demands of customers can help enterprises improve the new products.

From the figure 5, all the case enterprises have the high scores in customers. They all have the good collaboration relationships to the customers. For example, case enterprise A, SHFC has built the collaboration relationships to one of its customers, Kimberly, in 2004. SHFC got many ideas and advanced technologies from Kimberly, and finally SHFC developed many new products to meet the demands of Kimberly.

The scores of case companies in figure 5 are nearly the same, which means all the manufacturing SMEs, no matter the fabric manufacturing, or the pharmaceutical manufacturing, or the electronic instruments manufacturing, are agree that establishing collaboration relationships with customers is good for improving innovation performances. Customers are important for all of these case enterprises.

In fact, collaboration with customers can help enterprises generate more ideas from customers. While the ideas come from the customers, they are sometimes better than ideas from internal R&D process, because they can meet the demands by customers better. These ideas may help reduce the cost and time of new products, and improve the innovation performances.

5.1.2 Collaboration with suppliers

The collaboration relationships between enterprises can be treated as the linkages to the innovation network. According to Rothwell & Zegveld (1985), SMEs are lack of enough internal resources to innovation. This forces SMEs to look for external resources.

Establishing collaboration relationships with suppliers can improve the core competence of the enterprises. From figure 5, case enterprises achieve high score in suppliers. Collaboration with suppliers can improve innovation performances. While the enterprises are developing new products, suppliers with strategic collaboration can send experts join the development group. This can combine the core technologies to the new products and improve the value. Collaboration with suppliers can also reduce the cycle of putting products into the market and improve the competence.

According to the figure 5, case enterprise C, QSYC, scored the highest in collaboration with suppliers. In fact, during the process of developing new sensors and monitoring systems, they let suppliers join their development process, improve design and accelerate development based on the technologies of suppliers. The products designed with suppliers have fewer components, less assembling process and even higher quality.

The scores of case companies in figure 5 have some differences between each other. It can be found that QSYC achieves the highest score, and followed by ZSB. The score of ZCPC is the lowest. This is because their different business. The businesses about QSYC and ZSB are high-tech instruments manufacturing, which means the suppliers can take part in their innovation processes to help reduce the components or improve the quality. So suppliers are more important for these two enterprises. Meanwhile, the business of ZCPC is pharmaceutical manufacturing; the new products are mainly developed by its own. So suppliers are not important as others.

As the manager of QSYC said, through the collaboration with suppliers, manufacturing SMEs can reduce the supply cycle, improve the flexibility of supply, reduce the level of raw materials storage, reduce the cost of management, accelerate
cash flow, improve the quality of raw materials, improve order process, share the
technologies of suppliers, accelerate new product development, and reduce the
development cycle. The innovation performances can be improved by establishing
 collaboration relationships with suppliers.

5.1.3 Collaboration with competitors

According to the interview, all the managers mentioned that strategic collaboration
between enterprises, especially between competitors, has become more and more
commonly. While the market becomes more and more various, collaboration with
competitors can help enterprises meet the various demands by customers better. They
told the authors that, with the rapidly development of technology, the uncertainty of
investment in R&D and profits can be reduced by collaboration with competitors. So
it becomes commonly.

From figure 5, the case enterprises have established some collaboration relationships
with competitors. For case enterprise B, ZCPC, it formed an organization with its
competitors to share the information. ZCPC realized that it was hard for it to develop
new products alone. So it established strategic alliance with its competitors, shared the
costs and risks of new product development, and shared the technologies and
resources.

In China, it is good for manufacturing SMEs to establish collaboration relationships
with competitors. According to Chen, et al., (2006), SMEs in China are not mature,
they are lack of internal resources and they need external supplement. And also, there
are many manufacturing SMEs in China, but they are weak and dispersive,
combination can help them become stronger.

It is difficult for manufacturing SMEs to win the competition with single advanced
product or technology. While the market becomes more complex, traditional means of
competition are no longer suitable. As the managers of ZSB said, establishing
collaboration relationships with competitors can be a method to meet the various
demands of customers. Enterprises can share industry information and gather the
resources through collaboration. They can accelerate the speed of technology
innovation and reduce the cost of technology innovation. Moreover, they can reduce
the cost and risks of research and development.

The scores of case companies are different in figure 5. SHFC is the lowest while ZSB
is the highest. SHFC is a fabric manufacturing enterprise, and its innovation activities
mainly come from its imported spunlacing lines. Thus it has less demand of
information from competitors. However, ZSB is a high-tech instrument
manufacturing enterprises. The technologies in such field are changing rapidly, which
lead to a high demand of collaboration with competitors to get enough information
and knowledge.

Because of the huge cost of advanced technology innovation development and the
shorter life cycle of new products, manufacturing SMEs cannot afford such huge risks
alone. The demands of market change quickly, and manufacturing SMEs need more
information and technology innovation to adapt it. Thus strategic alliance is necessary
for manufacturing SMEs, and it will help manufacturing SMEs in many aspects. So
establishing collaboration relationships with competitors has the positive influences
on innovation performances of manufacturing SMEs.
5.1.4 Collaboration with universities and academic institutions

Nowadays, more and more enterprises dependent on the research results, experiment equipments, human resources, and research experiences. In order to realize the common benefits, enterprises and universities transfer the technology, share the resources, complement the advantages, and share the risks through collaboration. They utilize each advanced aspects, implement technology innovation projects, and transfer the high-tech outcomes to practical productive ability (Veugelers, et al., 2005).

From figure 5, these four case enterprises all pay attention have collaboration relationships with universities and academic institutions. In fact, they all have established excellent collaboration relationships with universities and academic institutions such as Zhejiang University, Qinghua University, East China University of Science and Technology, National University of Defense Technology, China Academy of Engineering Physics. ZCPC has even offered master degree of engineering courses with East China University of Science and Technology.

The innovation resources owned by enterprises and universities have complementarities. According to the manager of ZCPC, the invested innovation resources are mainly professional talents, scientific research instruments, knowledge and its property, technological information, research methods and experiences. Meanwhile, innovation investments by enterprises are mainly about innovation capitals, manufacturing instruments and place, demand information, and marketing management experiences. The necessary of university knowledge spread and the necessary of enterprise technology innovation, make up the market of collaboration innovation.

The scores in figure 5 are nearly the same. And also the average score of this characteristic is the highest. The advantages of collaboration with universities and academic institutions can be seen clearly. Thus all the companies are glad to have a good relationship with universities.

In China, outdated technologies and capital shortage make the innovation capabilities of SMEs weak. Thus, strategic alliances between manufacturing SMEs and universities can improve the innovation capabilities, improve the competence, and utilize the imported technology well. Collaboration with universities can also promote the collection of scientific research outcomes, technologies, capitals, and human resources. It can inject new vitality to SMEs, improve the core competence, improve the market share, and contribute to improve the innovation performances.

5.1.5 Collaboration with government agencies

According to Rothwell & Zegveld (1985), SMEs have disadvantages in financial and internal resources. They are lack of qualified technological human resources, and are lack of investment in R&D process. Innovative business activities are limited by these characteristics. So they need the support from external partners. The support by government agencies can be a strong assistant for manufacturing SMEs.

From figure 5, case enterprises have paid attention to build close relationships with government agencies. In fact, the managers of case enterprises told us they had all taken part in the industry trade promotion association (TPA). They could get the newest information from the database of TPA. The managers also told us that because of TPA, their costs had been reduced, and also their capabilities of innovation had
been improved. From the database of TPA, manufacturing SMEs can search the necessary information immediately, which can reduce the cost of information search. Meanwhile, when the enterprises have conflicts in resources, products or collaboration, TPA can help to find a win-win solution. This can reduce the cost of processing trade dispute. TPA also has the ability to help enterprises make decisions. This can reduce the cost of operating decisions before trade.

In China, the relationships between manufacturing SMEs and government agencies have become closer. More and more manufacturing SMEs realize the importance of government agencies. According to Yang (2004) and the interviews, government agencies have the abilities to analyze the trend of market economy and regulate the operation of macro economy. They are the indispensable part of market economy. Government agencies can provide the environment of fair competition. They have the abilities of communication and coordination. They can promote the optimization of industrial structures, and establish the manage system of intellectual property. Meanwhile, government agencies can reduce the cost of enterprises.

The scores in figure 5 are still nearly the same. This is because the innovation processes cannot be implemented without the support of government. The importance of government agencies are the same for all the manufacturing business. If the enterprises want to improve their innovation performances, collaborating with government agencies could be a good idea.

While government agencies can provide the manage system of intellectual property, the legislation and honesty of innovation development space can be established in the enterprises. In fact, innovation developments of some enterprises are puzzled by lack of intellectual property management. Problems of patents and brands are often happened. These problems hinder the enthusiasm of innovation in the enterprises, and make the competence of the enterprises weak. So enterprises require intellectual property and fair competition environment during the innovation process. Government agencies can give support in R&D, information, technologies, resources and fair competition, promote healthy development of industry, and provide the comfortable environment of innovation. So collaboration with government agencies can improve the innovation performances.

Table 10 shows the characteristics in the environment of open innovation to improve the innovation performances of manufacturing SMEs in China.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers</td>
<td>Meet the demands and generate new ideas</td>
</tr>
<tr>
<td>Suppliers</td>
<td>Participate in the innovation process and reduce the cost</td>
</tr>
<tr>
<td>Universities</td>
<td>Implement innovation projects and create new technologies</td>
</tr>
<tr>
<td>Competitors</td>
<td>Share the information and reduce innovation cost</td>
</tr>
<tr>
<td>Government agencies</td>
<td>Provide fair competition environment and supply R&amp;D processes</td>
</tr>
</tbody>
</table>

Table 10 characteristics to improve innovation performances
5.2 Motives

While the closed innovation paradigm has no longer been suitable for enterprises, more and more enterprises concern open innovation paradigm. Generation of ideas from internal and external innovation sources make open innovation flexible and advanced. In China, since the regulation and openness, enterprises start change their strategies from internal R&D process to external innovative sources.

As Rothwell & Zegveld (1985) mentioned, SMEs have some advantages when compared to large and multinational enterprises. SMEs have the capabilities to adapt to the rapid demands of the changing market. And their internal communication networks are efficient. According to Vahter, et al., (2012), SMEs can benefit more from innovative openness. Since the strategy of openness in China, SMEs in China will meet many motives.

For open innovation paradigm, ideas are generated from internal R&D process and external sources. External R&D can create significant value, while internal R&D is needed to claim some portion of that value (Chesbrough, 2003). The innovation capabilities of SMEs are usually limited by internal resources and outdated technologies. However, the environment of open innovation helps SMEs to find another way to improve their innovation capabilities.

Open innovation environment makes external communication of enterprises close. According to the interviews, manufacturing SMEs in China are able to achieve more information and technologies. They have motives to establish innovation networks, to form the industry clusters with their competitors. Thus, they can overcome their deficiencies in financing, and adapt to rapidly changing external environment. They can share information and technologies, they can share innovation development cost, and also they can reduce the pressure on innovative activities. Innovation networks link manufacturing SMEs to each other, thus manufacturing SMEs can cooperate with other partners to implement innovation activities with resources from both sides. The motivation of innovation for manufacturing SMEs will be improved.

Traditional manufacturing industries have small profit margins. However, open innovation environment provides many external innovation sources to help manufacturing SMEs improve the profit margins. For example, as the manager of QSYC said, the traditional upstream and downstream relationships with suppliers are no longer suitable for enterprises. While implementing open innovation, manufacturing SMEs can seize the motives to deepen and broaden the collaboration with suppliers. Share the information with suppliers and cooperate to develop new products can help reduce the purchasing time, reduce the cost, and improve the quantity. Meanwhile, manufacturing SMEs can choose operate with universities to generate new ideas and manufacture new products. Universities have research experience and research instruments, while manufacturing SMEs have marketing experience and manufacturing instruments. Cooperation with universities can make the motives to have a win-win situation. And also manufacturing SMEs can develop their technologies and improve the competence. There are another external innovation partners like customers, government agencies, innovation intermediary. Open innovation environment provide better accesses for manufacturing to cooperate with external innovation partners.

For manufacturing SMEs, single advanced technology or product is certificated unsuitable to the changing market. Limited by the weakness of capital and R&D
process, manufacturing SMEs cannot afford the cost to create necessary technologies and knowledge. They have the motives to import the advanced technologies from external sources. While the linkages between enterprises become close in open innovation environment, the transfers of technologies and knowledge between enterprises have been frequently. As the point of Chesbrough (2003), one abandoned idea may be useful for another enterprise. Manufacturing SMEs have more motives to gather different kinds of technologies and knowledge to improve their own competences and performances. Importation of new technologies can be a good way to reduce cost and improve the profit margins.

While due to closed innovation paradigm, the new ideas always come from internal R&D process. But SMEs do not have enough resources to be innovative. However, in open innovation environment, SMEs have many external innovation sources to choose. For manufacturing SMEs, environment of open innovation can support and motivate their innovation activities better. Because manufacturing SMEs cannot afford the high cost of create necessary technologies and knowledge only by themselves. They do not have resources and capitals. And they are lack of enough experienced engineers.

In closed innovation environment, the motivation of innovation in manufacturing SMEs will not be high. However, in the environment of open innovation, the costs of generate ideas are reduced, and the sources of ideas generation are become more. There are more resources and choices for manufacturing SMEs to implement innovation activities. Thus manufacturing SMEs are willing to implement innovation activities. From figure 9, we can see that case enterprises have benefited from collaboration with external partners. Open innovation activities help them reduce innovation costs, import advanced products or services, reduce the time to markets. These activities can be motivations for SMEs to implement more open innovation processes.

Figure 10 presents a short conclusion of motives of manufacturing SMEs of China in open innovation environment.

![Figure 10 Motives of manufacturing SMEs in China](image-url)
5.3 Challenges

Manufacturing SMEs in China have many motives in open innovation environment. However, in order to implement open innovation activities successfully, they have some challenges to meet.

Collaboration with external innovation sources (competitors, suppliers, universities, government agencies, customers) can be a good way to improve the innovation performances and core competences. However, from the questionnaire survey, even the collaboration relationships are necessary for manufacturing SMEs, there are still some problems in collaboration (Figure 6).

From figure 6, the level of trust among external partners is not very high, and the level of access to partners’ knowledge resources is not high as well. And also, it is presented in figure 7 that most innovation activities of case enterprises stay in the phases of idea generation. The scores of manufacturing and engineering are low. This is because the enterprises are afraid of secrets disclosing. In fact, according to the interview, managers of SHFC and ZSB told us that during the collaboration with external innovation sources, especially competitors, enterprises would not open all the resources to external partners. For manufacturing SMEs, they may establish well relationships with suppliers and universities, but they may not make enough internal resources become public when establish collaboration relationships with competitors. However, manufacturing SMEs would benefit most from competitors, because they are all flexible and alert to the changing demands of market, they are easy to have same words. Collaboration with external partners can help manufacturing SMEs developed, but lack of trust may lead to the challenge of implement cooperation.

Lack of technologies and investment often bother manufacturing SMEs. Outdated technologies and low capital lead to the weakness in innovation capabilities. Implementing open innovation could help manufacturing SMEs get more accesses to import new technologies. However, the challenge is, most manufacturing SMEs only know importation of new technologies, but they do not know how to transform the external new technologies to their own (Yang, 2004). They know new technologies will improve their products, but do not know how to improve. So they may fall into the vicious circle of “importation-fall behind-importation-fall behind”. This means, the enterprises import the advanced technologies, but cannot transform the technologies to their own, they waste money and fall behind. And they want to improve their performances and just know importation can do help. So they waste money to import technologies twice and fell behind again. Blinded importation of new technologies has become another challenge for manufacturing SMEs in open innovation environment.

At last, intellectual property dispute is another challenge faced by manufacturing SMEs. From figure 8 we can find that the case enterprises use several intellectual property protection mechanisms in the collaboration with external partners. Patents get the highest score, while others are nearly the same. Different enterprises use different strategies to protect their intellectual properties. However, even the trade promotion association and government agencies try to provide a fair competition environment, many manufacturing SMEs are involved in unfair competition and redundant low-level development. According to Liu (2008) and the interview, many managers of manufacturing SMEs are lack of intellectual property protection. During the innovation development, the problems of patent dispute or brand dispute are often
happened. These problems are not only hindering the motivation of innovation, but also reduce the influence and competence in both internal and external market. Moreover, intellectual property dispute can make manufacturing SMEs fear to establish collaboration relationships to external innovation sources. When this happened, some manufacturing SMEs would be eliminated by the market because of the outdated technologies and old products. So manufacturing SMEs in China need to find ways to overcome intellectual property dispute that in the environment of open innovation. Figure 11 presents a short conclusion of challenges of manufacturing SMEs of China in open innovation environment.

Figure 11 Challenges of manufacturing SMEs in China
6. Conclusions and limitations

In this thesis, there are some methods to help manufacturing SMEs in China to improve the innovation performances. In fact, one of the biggest differences between closed innovation and open innovation is that the boundary of enterprises has been broken. The linkage from internal to external is closer. And open-minded strategies make manufacturing SMEs to look for external innovation partners actively. Collaboration becomes more and more important in the environment of open innovation.

In order to improve innovation performances, manufacturing SMEs in China need to cooperate with external innovation sources. There are five sources for manufacturing SMEs to establish collaboration relationships. They are customers, suppliers, competitors, universities and academic institutions, and government agencies. Suppliers can help manufacturing SMEs reduce the components of the products and improve the quality. Customers can provide new ideas and make manufacturing SMEs adapt to the demands of market. Universities can provide research instruments and experiences for development of new products. Competitors can motivate innovation processes and share information. Government agencies can provide fair competition environment and coordinate trade disputes. Thus, establish collaboration relationships with these five external partners can improve the innovation performances.

Some answers can be found for the research question “What are the motives for manufacturing SMEs in China to implement open innovation?” Because of the strong power by open innovation paradigm, manufacturing SMEs in China have some motives to implement innovation activities. They can form innovation networks, and get information and technologies from the networks. They have better accesses to cooperate with external innovation sources. The innovation performances will be improved through the cooperation. They have more accesses to import advanced technologies instead of generating ideas from internal R&D process. They can improve their competences from the importation. And at last, compared with closed innovation, open innovation provides good environment and accesses to motivate SMEs to implement innovation activities.

And also, for the research question “What are the challenges for manufacturing SMEs in China to implement open innovation?” we can find that as China is only a developing country, there are lots of problems in the market. The manufacturing SMEs in China still meet some challenges in open innovation environment. Collaboration with external innovation sources can be the best way to improve technologies and innovation performances. However, manufacturing SMEs are lack of trust in collaboration. They are feared to leak their own business secrets. In this situation, collaboration with external partners will not work well to improve innovation performances. Meanwhile, some manufacturing SMEs are involved in the vicious circle of “importation - backward – importation - backward”. They do not have abilities to transform the imported technologies to their own, and that will decrease the innovation motivations and performances. The market of manufacturing SMEs is not very mutual in China. They do not have enough support from the country, and they cannot get enough extra investment in R&D process from the country. And at last, manufacturing SMEs in China are often bothered by intellectual property disputes. Some managers are lack of the concepts of intellectual property,
and the disputes will destroy the motivation of innovation. If the manufacturing SMEs in China want to develop rapidly, they should find solutions to overcome these challenges.

In the environment of open innovation, manufacturing SMEs need to seize the motives and overcome the barriers to improve their innovation performances and profits margins. Some advises were listed here for manufacturing SMEs in China to improve their performances.

First of all, they can establish collaboration relationships with external partners. Collaboration is most important because open innovation environment encourages external communication. Manufacturing SMEs can get resources and technologies from external sources, and it will be win-win situation in collaboration. It is hard for single SME to create new things alone. If manufacturing SMEs want to implement innovation, they have to dependent on the methods of openness, cooperation, and dynamic integration.

Second of all, they should improve the knowledge of intellectual property. Lack of trust is commonly exists in collaboration, and it becomes the barrier for development of innovation in manufacturing SMEs. Additionally, intellectual property disputes have become another challenge for innovation in manufacturing SMEs. This advice can help manufacturing SMEs reduce the unnecessary R&D, improve the resources from external partners, and finally become more competitive.

Third of all, the government of China should increase the support of innovation in manufacturing SMEs. The development of manufacturing SMEs in China cannot live without the support of financial from the government. In China, most of the manufacturing SMEs have to survive with their own capitals. The level of management in such SMEs is not very high, and the profit ratio is low in manufacturing industry. So the abilities to overcome the risks of manufacturing SMEs are weak. Until now, China has paid less attention to the development in manufacturing SMEs than developed countries. So the government should put forward some policies and increase the investment in manufacturing SMEs. As it is presented in table 4 that increasing investment rates lead to increasing innovation performances. And also, the government can establish the service institutions (technologies, information, consultation, R&D.) for manufacturing SMEs.

This thesis has some limitations. First, there is not enough data and the real innovation business activities to evaluate the whole innovation performances in case companies. And the focus is the collaboration relationships to improve innovation performances. There might be another method to improve the performances. Secondly, the analysis could be expanded to other companies to understand how valid the results are.
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Yin R. K., (2009), *Case study research: Design and methods*, Sage, California
Appendix 1: Interview outline

In the interview, some questions were formulated. The interview aims to get information of some open innovation activities of case companies, and the managers’ attitudes and opinions to the open innovation. The outlines were prepared in Chinese, and this is the translation from Chinese to English. The questions are as below:

1. Please introduce your company. What is the main field of your business? What are the advantages of your products?
2. What do you know about the conception of open innovation? Do you have open innovation activities? Please introduce some in details.
3. What is the rate of investment in R&D each year? Which part did the innovation mainly focus on?
4. Do you concern about the new break technologies which may influence your company initiatively? Do you take actions to new technologies immediately, like importation? Do you change the technological standards to adjust to the demands of new products?
5. Do you establish collaboration relationships to external partners, like customers, suppliers, universities? What is the way of collaboration?
6. Do government has some policies to support innovation in your industries?
7. How many patents do you get each year?
Appendix 2: Questionnaire Survey

The survey was sent to the case enterprises when the questionnaire surveys were implemented. It concludes 8 sections, but some data of the questions are not used in this thesis. Finally we present five used questions.

Section 1. General data of the company

1.1 Company name:

1.2 Please introduce your contact details (including email address) if you are interested in receiving a copy of the final report:

1.3 Please indicate you company’s main economic activity:

1.4 How many employees are in your firm (full-time and part-time)?

(1) < 9  
(2) 10-49  
(3) 50-249  
(4) 250+

1.5 What was your expenditure on R&D as a percentage of sales over the last 2 years?

(1) < 1%  
(2) 1%-2%  
(3) 2%-5%  
(4) > 5%

Q1. Please indicate the extent to which your firm has collaborated with the following stakeholders in innovation activities over the last 5 years:

<table>
<thead>
<tr>
<th>Universities and research centres (1)</th>
<th>Not at all 1 (1)</th>
<th>2 (2)</th>
<th>3 (3)</th>
<th>4 (4)</th>
<th>5 (5)</th>
<th>6 (6)</th>
<th>To great extent 7 (7)</th>
<th>Don't know 8</th>
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</thead>
<tbody>
<tr>
<td>Innovation intermediaries (2)</td>
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<td>Government agencies (3)</td>
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<td>Customers (i.e. retailers) (4)</td>
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<td>Suppliers (5)</td>
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<td>Consumers (6)</td>
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<td>Competitors (7)</td>
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<td>Companies operating in other industries (8)</td>
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</tbody>
</table>
Q2. Please indicate the extent to which your firm has collaborated with external partners in the following phases of the innovation process over the last 5 years:

<table>
<thead>
<tr>
<th>Phase</th>
<th>1 (Not at all)</th>
<th>2 (2)</th>
<th>3 (3)</th>
<th>4 (4)</th>
<th>5 (5)</th>
<th>6 (6)</th>
<th>To great extent 7 (7)</th>
<th>Don’t know 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idea generation/exploratory research (1)</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Experimentation (2)</td>
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<td>Engineering (3)</td>
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<td>Manufacturing (4)</td>
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<td>Commercialisation (5)</td>
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</table>

Q3. Please indicate the extent to which your company uses the following intellectual property protection mechanisms when collaborating with external partners in innovation activities:

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>1 (Not at all)</th>
<th>2 (2)</th>
<th>3 (3)</th>
<th>4 (4)</th>
<th>5 (5)</th>
<th>6 (6)</th>
<th>To great extent 7 (7)</th>
<th>Don’t know 8</th>
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</thead>
<tbody>
<tr>
<td>Patents (1)</td>
<td>○</td>
<td>○</td>
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<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Designs (3)</td>
<td>○</td>
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<td>Trademarks (5)</td>
<td>○</td>
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<td>Trade secrets (6)</td>
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<td>Non disclosure agreements and other contractual agreements (e.g. joint development agreements) (7)</td>
<td>○</td>
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<tr>
<td>Copyrights (8)</td>
<td>○</td>
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</table>
Q4. Please indicate your agreement with each of the following statements with respect to your firm’s experience in collaboration in innovation with external partners:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree (1)</th>
<th>2 (2)</th>
<th>3 (3)</th>
<th>4 (4)</th>
<th>5 (5)</th>
<th>6 (6)</th>
<th>Strongly Agree / Don’t know (7)</th>
<th>Don’t know (8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>We share a similar management style with our partners (1)</td>
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<td>There is a mutual interest in working collaboratively among partners (2)</td>
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<td>There is a high level of trust among partners (3)</td>
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<td>Partners’ technological competences match up (4)</td>
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<td>Access to partners’ knowledge resources (5)</td>
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<td>Synergy created by combining knowledge among participating firms (6)</td>
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Q5. Please indicate how well collaboration with external partners in innovation activities has performed against the following objectives over the last 3 years:

<table>
<thead>
<tr>
<th>Objective</th>
<th>Not at all (1)</th>
<th>2 (2)</th>
<th>3 (3)</th>
<th>4 (4)</th>
<th>5 (5)</th>
<th>6 (6)</th>
<th>To great extent (7)</th>
<th>Don’t know (8)</th>
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<tbody>
<tr>
<td>Reduce Innovation risks (1)</td>
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<td>Reduce new product/process development cost (2)</td>
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<td>Reduce time to market (3)</td>
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<td>Introduce new or significantly improved products or services (4)</td>
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<td>Introduce new or significantly improved process of producing our products or services (5)</td>
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<td>Opening of new markets (6)</td>
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