



REVIEW ARTICLE

INNOVATION IN LOW TECHNOLOGY INDUSTRIES: CURRENT SITUATIONS AND FUTURE PROSPECTS (CASE STUDY OF GERMAN INDUSTRIES AND COMPANIES)

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ABSTRACT

This article focuses on the industrial sector that is said to be low-tech or completely non-investigation and often has been formed the whole industry. The focus of this research, above all, is created by the critique of the mainstream of innovation, focusing on its high level technology. However, industry research with low and medium technology (low and medium technology industries) can structurally demonstrate that the completely non-research industries are innovative surprisingly, and play an essential role for the development of modern economies. Following up on the background, the industrial sector has gained the front-end innovation capability with low and medium technology (low and medium technology industries), in intelligent trending of available technology and existing knowledge, and their combination with high technology components. Therefore, the findings of the research presented here, come to the forefront in the hypothesis that hybrid innovations open up hopeful development perspectives for traditional industries. It has been pointed out that combined innovations are innovations, based on market-specific reforms of available technologies, and existing knowledge, as well as features based on their combination with new high-tech components. The basis of the methodology of reasoning is a systematic analysis of the industrial, industrial and industrial research of low and medium technology, which emanates from almost the past 10 years.

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INTRODUCTION

In recent years, a research field has been in research of international innovation, related to industries that do not do research and development. The main focus of this research is the sectors and manufacturing companies. These industries can be called, in the name of complete industries without research and industry because they have progressed in their life cycle. The key criterion for classification is the amount of research and development, which indicates the company's average investment rate in research and development activities to its revenue from sales. Based on these criteria, the industries with the research and development under 3 percent, are considered as absolutely no research industry. These sections are called low technology or low-middle technology in international use. For example, the industries that produce are basic metals, rubber and plastics, food, beverage and tobacco, furniture as well as wood, paper, make up this section. On the contrary, all parts that have higher levels of research and development, called as research thoroughly parts, or high-tech or medium-high technology.

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Examples of high-level sections in this area are office, accounting and accounting machines, medical, optical and precision instruments, and pharmaceuticals. The parts of vehicles and trailers, machinery and equipment, have high average of research and development. Research interest in low-tech industries and medium-started, in essence criticizing the research and innovation policy mainstream, on the basis of high investment in research and development and advanced technologies is driver key of growth and success. And this assumption can lead to a near-unique focus on the economic sectors, with a high degree of research and development, with the economic significance and the ability to innovate in particular the low-tech industries, which has been examined. In contrast, two research findings have emerged, in particular in the field of low and medium technology industries. First, low and medium tech industries, that are innovative in terms of technology, surprisingly and their relationship, given the ability to innovate the overall economy, should not be overlooked. Secondly, the importance of a fully-fledged industry has been greatly enhanced, in terms of their contribution to employment and growth. Thus, in the second half of the last decade, 11.7% of the workforce was hired, in the 27 EU, in the low and medium technology industries. Of course, in general, this percentage varies among different countries. In Germany, roughly 50% of the industrial workers

are hired, in the sectors of low and medium technology industries, in 2006, and these sectors account for almost 42% of the total industrial added value. In addition, there is little structural change between sectors with variable amounts of research and development in recent years (Som, 2011). This paper summarizes the findings of the study on innovation in the low and medium technology industries, and discusses the development aspects of these industries in advanced societies. The goal is to demonstrate the specific innovation capabilities of the full industry, and their future innovation capacity. We will recognize this innovation pattern, as a combination of innovations in this article.

This article is organized as follows. The dominant innovation model will be presented in the manufacturing industry, with low and medium technology, in Section 3.2, taking into account the fields of innovation, the fundamentals of knowledge and the combination of forms. The innovation is known as an activity that includes research and development activities, the successful development and marketing of new products, the introduction of new manufacturing technologies, and the reorganization of processes, hence, innovation consists of technical and non-technical components. Therefore, this article distinguishes between organizational and technical process innovations, on the one hand, and service and student innovations on the other. The marketing innovations include all of these dimensions (Fagerberg, 2005). The basis of the methodology of the following argument is a systematic analysis of the research of the low and medium technology industry, which occurs almost 10 years ago. These results include a large number of studies that have examined the situation, across the EU from a variety of aspects, and have been, studies, following the German innovation system. Methodologically, each of these studies have followed, the statistical-quantitative method (Arundel, 2008), or acquired their findings, based on quantitative research findings in the field of case studies (Palmberg). Based on this background, the present study deals with the status of the industry of low and medium technology, in Europe generally, as well as the specific situation of Germany.

Theoretical Foundations

Innovation Patterns for the Low and Medium-Sized Industries

Innovation Areas

This issue has not been discussed, in the background, that the low-tech industry should be considered in an innovative way, it has been assumed that at least half of the innovative companies in Europe do not have any internal research and development capability (Huang, 2010), (Arundel). However, it has been shown that low and medium technology industries have less innovation than high-tech industries. According to data analysis from the EU innovation research, more than a third of the low and medium technology industries (37%), were initiators, between 2002 and 2004, while more than 55 percent of high and medium technology industry companies had an initiative in this period (Heidenreich, 2009). It has been emphasized this fact that the innovation activities of low and medium sized industry companies are guided in essence by the development and enhancement of existing technologies (Arundel, 2008).

The Importance of Process Innovations

With regard to the main fields of innovation, we can summarize the findings of the research, as follows: The study is in relation to the reference to the importance of the innovation process, as virtualization (Huang, 2010), (Kinline, 2009). Based on CIS analysis in 2004, these innovations have almost double the importance of low-tech and medium-sized industries, compared with high-tech and high-tech industries, with 36 percent, compared to 17 percent of all innovative companies. However, data of 2009 confirms these findings, from German studies. This data shows that the amount of used technology does not fit with the degree of research and development, and low and low technology industries have a widespread capability to adapt new production technologies for their own purposes. This feature applies, in particular, to the introduction of complete and created technologies. However, it is evident that advanced process technology is being used by firms with high and medium technology industries (Rammer, 2011), (Som, 2012). However, it can be considered that only a small minority of companies with low and medium technology industries, as new technology vendors and ready-to-use process technology technologies. In addition, the vast majority of these companies have been focusing on out-of-the-box activities, along with the mixing and adaptation of new technologies in their manufacturing processes (2010 Huang). Often, there are proximity links between technical process innovations and innovations in the desired organizational structures, such as the introduction of new forms of the company, or the organization of work, or new logical concepts.

The organizational innovations are often intrinsic and is related with the technological innovation of processes, fundamentally. However, organizational innovations can guarantee a competitive razor for companies because their imitation is hard, by competitors, because of their non-imitation nature. Also, these innovations are driving the new marketing strategies that have great importance for low and medium sized technology industry companies. As the existing data shows the innovation of the organizational process and, therefore, the high priority of the target, with the companies of the low-tech and medium-sized industries, as a whole, and in this regard, are a little differentiated from fully investigative companies. In fact, data shows that 61 percent of all low-tech and medium-sized industry enterprises have paid 59 percent of fully researched companies in the manufacturing sector to enterprise innovations in 2009, (2012). Som O. These adaptive activities often occur, in the context of the current operations, in order to manage production. Therefore, additional investment in internal research and development activities is not necessary normally. Secondly, competition applies the prevailing cost in low-tech and medium-sized industries, on business enterprises, to focus their innovation efforts, on manufacturing processes, that allows them to reduce costs quickly to increase their performance and ensure competition (Kiriner, 2009).

The growing importance of product innovations

The Product innovations give the same importance, to those product innovations (Rammer, 2011). However, a comparison shows that product innovations for high and medium technology industries are much more important than low-tech industries. Based on CSI data, slightly more than 18 percent of innovative company's low and medium-sized technology

industries focus on manufacturing innovations but more than 30 percent of high-tech industry companies do this (Arundel 2008). The data, indicating a similar relationship for Germany (Remmer 2011). However, it can be concluded that product innovations are followed by the use of new technologies (2010 Huang). This is called technology-based capabilities; and it's probably specialized the research and development capabilities that low-tech companies often have not it. It can be relied on additional findings, based on a closer examination of product innovation, (Som, 2012), (Hirsch-Kreinsen). Initially, innovation activities in the industry of low and medium technology are often limited to the continued development of the continuous product. The product components often grow, in addition in terms of their materials, performance and quality, which are compatible with varying customer demands. Therefore, this is called the innovation strategy, the stage-by-stage development of the product or these companies are famous as low-tech manufacturers (Som, 2012). Second, it can be identified, product-based innovation, which includes design based on production and performance, and product technical update.

These criteria have a close relationship, with the innovation of a market-based and organizational process. The low-tech and middle-tech companies pursuing this strategy are looking for a quick response to changing customer preferences, and are trying to take advantage of the market, with brand strategy tools that have skills and activities related to the developed product. However, with regard to service technologies that are independent of technical products, it is clear that these innovations have a higher priority in low-tech and medium-sized industry companies compared to fully-researched companies in 2009. Therefore, it is evident that, low-tech and medium-sized industry companies are looking to develop their own Portfolio products (Som, 2011). In general, this background points out that many low and median technology industries know that service innovations have a potential significance (Kirmer, 2008). In this regard, the background has shown the importance of design and marketing for this focus of innovation, and focuses on this focus, as a customer-driven strategy, and on its companies as the developers of the product of business-to-consumer (SOM, 2012). The mentioned core features of the innovation strategy above include not only the intelligent and systematic modification of existing product technologies, but also their development is new with technical and non-technical components for their respective companies and their sales markets.

Knowledge Base

Innovation research has consistently identified the important role of existing knowledge, in each field, for the source and success of innovations. However, at the same time knowledge is a source of information that can be gained with key strikes for innovation (Mallerba, 2005). At this point, the relevant background represents the structural results that show a significant distinction between the basics of internal and external knowledge and their related information resources (Noumlall, 2011).

Internal skills and knowledge

As the quantitative analysis of low and medium technology innovation shows, the basics of internal knowledge have a relatively high significance for a successful low- and mid-tech industry innovation process.

Based on CIS data analysis, for the 20 European countries, this domestic information source is considered to be of high importance for innovation of 40.6 percent of the total low and medium technology industries Initiator. Instead, the activities of innovation are pursued, in the form of semantic and practical means, by doing and using them. Hence, the knowledge associated with these companies can be understood as practical user-based knowledge (Arundel, 2008), (Maskell, 1998). This expression represents the complex range of different components of knowledge that they represent, formalized, coded, and distinct components, such as drawing the design and characteristics required for new products, as well as, above all, implicit properties, Like the accumulated experience. The relation of this kind of knowledge can be prototyped by referring to the process innovation activities (Rammer, 2011). Here, businesses are considered, for the use of engineering knowledge that is compounded and documented, in their production facilities and operational structures. However, ongoing innovation and implementation criteria are required. The necessary prerequisite is the available knowledge on the purchase category. As shown above, process innovations often occur in the context of the current operating processes, in addition, they start, potentially and run always by the employees who are responsible for the current, like technicians and even workers.

Essential External Knowledge

The research of low-tech and medium-sized industries shows that the basis of the company's external knowledge plays a more vital role in the innovations of low and middle-tech industries. The main reason for this is that low and medium-sized industry companies can moderate limit their research and development resources, simply by adapting foreign knowledge (2005.Bender). As shown, it plays a more important role for low and middle-tech industries based on quantitative data from the number of sources, markets and market information of customers and competitors, regarding the necessity of innovation. Based on CIS data for the 20 member states of the European Union these resources taken together have a great importance with more than 35% of the low and middle-tech industry companies (Heidenreich, 2009). As more detailed studies show, customer input plays a big role in product innovations. According to CIS data this source of information has particular importance for almost 24% of the low and medium technology industries (Heidenreich, 2009). Certainly, cooperative relationships can be useful between innovative companies and customers, in many cases, Thus, more than 60% of the low and medium-sized German industry companies participated in the innovation collaboration with customers in 2009. However, low and medium-sized technology industry companies have a rather small difference than fully research-based companies, given the importance attached to marketing and market information and customer relationships. Because, if customers and competitors have not a more important role; they will have a similar role in this company innovation. Nearly 25 percent of all low-tech and medium-sized industry companies from the 20 EU countries have described this information source as very important, while this statement is correct, only 18% of fully investigative companies (Som, 2012). Collaborative relationships with suppliers, proved that it is important for the firm's ability to innovate. At the time of the introduction of proper manufacturing technologies, in 2009, more than two-thirds of the low and low technology industries came together with

suppliers in Germany. The company's innovation is widely based on their capabilities, for the components of the technical-process organizational process, which is called embedded knowledge, and for adapting it to personal needs. Finally, the mediated knowledge which was created plays a significant role in the innovation capability of the low and middle technology industries. This background has identified a number of non-corporate organizations, such as research institutes, consulting firms and exchange companies, that act as sources of information. Therefore, they emphasize that the use of advisers, staff recruitment and foreign research and development are significant foreign sources of innovation in the low-tech and medium-sized industries. According to Heinrich's analysis of CIS data, 6.2 percent of high and median technology enterprise companies pointed to a particular sector as an important source of information, compared to 3.2 percent of all industry companies with low and medium technology innovator, data from the German industry, which show the same coefficients (Som, 2012). The relationships between low and medium technology industries and foreign scientific institutions, are much less abundant and business enterprises are quite research-intensive.

Organization and knowledge management

What is including high importance for the innovation of low and medium industries, and the procedure that in which they use of existing domestic and foreign knowledge. In a coherent sense, innovation research determines the importance of routine issues, corporate procedures and company structures, the dominant relationship and forms of participation, and the respective quality and staffing structures (Cohen, 1990).

Small and medium-sized Companies procedures

As show the results of the research, the innovation courses that reviewed here are strongly formed by the current structures of small and medium size businesses enterprises, and as the data show, low and medium technology industrial businesses with small and medium-sized businesses are dominant. This statement is true for whole Europe and Germany situation. In 2009, more than 60 percent of all industrial companies with low and medium sized technology in Germany include small and medium businesses with fewer than 250 employees (Som, 2012). In result of dominant structural patterns in these companies are described with a limited set of resources and capabilities for strategic activity. These companies have few resources from the point of capital, skills and knowledge, and their degree of specialization of managers is often low. Generally, the background emphasizes that the courses and methods of innovation in low and medium technologies industries show a low degree of formalization. Thus, it has been reported that low and medium industry companies have applied systematic innovation of management practices that are less frequent than those of high and medium industries were done. For example, this tendency applies to use of innovation-based incentive schemes, the combination of functional forms related to innovation in target reasoning, selective quantitative criteria, and the existence of forms of innovation promotion from a work organization, such as innovation cycles, teamwork and temporary project groups (Som, 2012). In addition, research results show that these structural features apply to the majority of innovator companies in low and medium industries, and are largely unrelated to the type of technology which are pursuing.

These companies concerns with high levels of merits and general about described working organization.

Informal Cooperation

As already mentioned, the relationship between external knowledge and information resources shows the high importance of collaborating with low and middle technology industries with external partners. The background emphasizes that the principle of development and communication has less important for low tech and medium industry companies than the mainstream of research and development, which is predominantly dominant in low and medium technology industries (Huston, 2006). Thus, data in the German industry for 2006 to 2008 show that in product innovations, 15 percent of low and medium industry companies and only 5 percent of the total research companies have applied advanced foreign innovation, for process technology, these features are 27 percent for businesses and less than 10 percent for high and medium technology and industries.

Moreover, the data mentioned above shows the importance of cooperative partnerships for low and medium technology companies for manufacturing technologies, roughly 30% of the entire high technology companies with high technology industries work with other activists, especially customers, While nearly 15% of the firms in the low and medium technology industries fully adapted the previous developed products, for the process innovation process, the cooperative relationships with suppliers are overcome, as previously demonstrated. However, it is clear that in comparison with comprehensive investigated enterprises, low and medium technology industry companies are relatively rarely formalized and contractual agreements are signed based on cooperation with foreign partners (Chen, 2009). Thus, data in the German industry shows that only about half of the cooperative relationships between low and medium technology industrial companies and other partners have a contractual basis. On the contrary, it can be argued that cooperative relationships in the industry with low and medium technology are highly informal and based on individual relationships (Rammer, 2011). Data on the food industry in Germany also show that formal communication constituents the traditional form of cooperation, while more formal methods are less frequent (Menrad, 2004). These findings are quite possible for three reasons. Initially, informal cooperation practices are often preconditions for low and medium technology enterprises in the industry, so that they cannot identify untrustworthy, tactical, and untrained customers (Grimpe, 2009). Second, predominance of small and medium businesses plays a significant role as these enterprises are hesitant in joining formal cooperation and prefer personal-centered informal relationships. Third, low levels of competency of low and medium technology industries reduce formalized co-operation with external partners instead of increasing partnerships. Against, research findings show that firms with more deserved employees or with research and development departments often formally collaborate with external partners.

Communication of combined Innovations

In conclusion the research findings, we can identify a particular innovation model that is called composite innovation. This concept is used to describe these innovations in low and middle technology industries that are described by combining different innovation activities.

These innovations consist of technical and non-technical components and are strongly oriented towards foreign knowledge sources as well as sales markets. Experimentally, this pattern was applied to the innovation strategies mentioned above from process privatization to a customer-centric strategy, or product developer to the customer. On this basis, the study states that low and medium technology industries innovations are often developed beyond advanced developments and do not focus solely on a nuclear activity, such as process or product innovation (VOnTunZelmann, 2005).

According to available data, 40% of innovative German enterprises in the German manufacturing sector carry out these innovation activities, which also called them hybrid innovations for the period 2006 to 2008 (Rammer, 2011). In addition, researchers emphasize that this particular type of innovation is significantly rising. Low and medium technology industry companies are increasingly combining design-based product innovations with technological and organizational progress, more importantly; they are introducing new business models that have a strong tendency towards market demands and the needs of specific customer groups. Top of all, researchers have determined the importance of designing of product design and market based process as the underlying drivers for innovations in the low technology industry (2008, Arundel). However, as the research findings show, this type of innovation needs two key conditions: firstly, low and medium technology industry companies should be able to manage an exhaustive set of external knowledge sources, based on distributed knowledge, say in the background (RObertSON, 2009). This foundation consists of different forms of knowledge applied by activists who are independent of each other and often come from different parts and fields of technology. Experimental findings suggest that the main source for creating knowledge of low and medium technology industry companies latent here.

This source of information transmits knowledge and technology transfer processes between low and medium technology industries and high technology industries, and are credible by implementing a fast growing role in the innovation capabilities of low medium technology industries (Potter, 2009). Second, the research findings shows the importance of specific capabilities that enable low and medium technology industry companies to identify valuable knowledge in their environments in order to combine knowledge into their existing knowledge collections and use it for innovation. This feature can be considered as a key foreground, especially for successful process innovations. Key activists often include the nomadic cycle of management representatives and technical specialists. From a wider perspective, research pursues a dynamic capability approach, which makes sense as convexity (Bender, 2005), which can be considered as the main potential of low and medium technology industries, and it is referred to as the transfer of knowledge to the process of innovation of the low technology industry. Emphasizes this point and states that high technology companies demand (some degree of in-built capabilities) to understand, follow up and interact with the supplier of descriptions to facilitate the recovery of traditional recovered goods) (Mendon, 2009). According to the author, these capabilities often lead to the very dynamic development of low technology industries, as this particular capability for combining new technologies should be steadily evolving from the perspective of overall technological change.

Conclusion

As a result, this paper examines the question of the sustainability of an in-depth innovation model, and that low and medium technology industry companies can not only be secure, but also can expand their operations to major business locations in developed countries such as Germany. Give this question can be answered positively from the perspective of the findings of the current research. Researchers have been struggling to identify the remarkable economic sustainability of the low technology industry segment. So, despite the fact that completely research section had a significant outflow in recent years, growth rates in the low and medium technology industry have been very high in the past decade. This finding is particularly relevant for the German industry and in the wider Europe. The innovation of many companies from the low and medium technology industry has been confirmed with this success (Kaloudis, 2005). Moreover, many firms' sustainability of low and medium technology industries is based on additional factors. First, knowledge transfer processes play a central role.

However, these transfer processes do not take place in the same direction; the relevant innovation momentum of the table is transmitted to the reverse direction. These impulses come from a simple but often overlooked fact that the benefits of selling new technologies to depreciate and to continue to invest in research and development by research firms are essential. In addition, additional impulses result from the economic and technical characteristics of the needs of new and emerging technology companies. These conditions often affect the development of new technologies if the needs of specific users are compatible with the needs of other users as much as possible, and thus, from the perspective of the manufacturer, the broad field of use for complex products. In other words, low technology companies, continuously and creatively, combine, update, and transfer key technologies of current industrial transmission. Second, transfers between different knowledge sources can potentially lead to the emergence of new technology sectors. With a new global knowledge adaptation, low technology industry companies can not only develop the function of new products, but also expand the range of technology opportunities (Freddi, 2008). This process can be conceptualized as a synthesis of conceptualization technology.

An example of this process is the creation of a mechatronics field of technology. Third, the present study provides a knowledge-based business activity that provides many opportunities for low and middle technology industries to develop sustainable business strategies and open up new market segments and stimulate new customer preferences. The key prerequisite for systematic use is the high technology knowledge base and the underlying components of the company and the existing sector. Eventually, these findings can be linked to the discussion of innovation research on cost-effective innovation. The term refers to simple, effective, and ambitious innovation. In essence, this discussion examines the needs of emerging fast-growing markets in developing countries such as China, India and Brazil and yet the discussion has already been related to the market capacity of highly developed countries. Therefore, focusing on growing market sections relevant to customer groups that only have declining or insecure revenues or those for different reasons are less willing to buy high technology products high due to

circumstances. However, nowadays, only the products of main international companies are cited as examples of such innovations, such as medical devices with simple use. This topic can be a reason for this development, as well as new horizons for the low and medium sized industries in developed countries. Specific features of the mentioned low and middle technology industry innovation patterns are generally similar to the properties of the concept of cost-effective innovation: both tend to focus on the specific composition and intelligence of those of the new technology components at the product and process levels. In the perspective of rapidly changing revenue structures and customer preferences, sales capacity that previously have already taken up emerged, especially in situations where customer closely and validated analysis capacity are necessary and given the internal market dependencies and final pricing pressures, this capacity can certainly not be verified by all the processes of low and medium technology industries. An increasing number of opportunities has been emerged, for example, for specific customer products, and fully designed to provide flexible and validated standardized and of course, advanced technology components in different production chains. The main condition for the success of low and medium sized industry companies in this field is their ability to innovate.

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