# Review of Innovation Theory Research on Low and Medium Technology Industry

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**Abstract.** In the age of "knowledge economy", the innovations in high-tech industries, especially in information and communications technologies (ICT), and biotechnology industries are regarded as the hot topics among academic and policy makers. However, the traditional (mature) industries still account for large shares of employment, production and exports in virtually almost all countries – and will continue to do so for quite some time. Therefore, there are some scholars who pay special attention to low- and medium-technology (LMT) Industries' innovations, and have made some achievements. Based on a part of literature of LMT Industries' innovations theories, the subjects of the characteristics, strategies, and policies in LMT Industries' innovation s are discussed in the paper: 1) the characteristics of the innovation in LMT industries are dominated suppliers, new technologies, market demand and external sources of innovation; 2) Incremental innovation and architectural innovation (or step-by-step, customer oriented, process specialization) are perhaps the suitable strategy choices in LMT industries; 3) the policy makers should pay more attention to the innovation in the LMT industries and develop the customized supportive policy to boost technical progress and upgrade the LMT industries. Innovation is a complicated thing; the paper provides useful meanings for policy makers and managers to better understand innovation in LMT Industries.

## Introduction

Starting with the classification of manufacturing industries into high-tech, medium-tech and low-tech sectors by the OECD, this distinction has been widely adopted. The classification of sectors is based on the respective sectors' average share of expenditures for research and development (R&D) [1]: high-technology sectors (high-tech) with a R&D intensity or more than 5%, sectors with complex technology (medium high-tech) with a R&D intensity between 3% and 5% and industries which are not research intensive (medium-low-tech and low-tech) with a R&D intensity below 3%. For example, "more mature" or "traditional" industries such as the manufacture of household appliances, the food industry, the paper, publishing and print industry, the textile industry, the wood and furniture industry, as well as the manufacture of plastic products are generally regarded as in LMT industries.

The same as high-tech industries, LMT industries play a vital role in the society and it is undoubted that LMT industries are indispensable to the national economy. However, the fact that both industrializing and industrialized countries have a large proportion of LMT industries, both in the manufacturing and service sectors is often simply overlooked [2]. Therefore, "Policy and Innovation in Low Tech" (PILOT) in Europe is a fundamental criticism of the widely held focus on high technology, and the same time many papers about innovation in low-tech industries are published by the colleagues of the project consortium in PILOT. A top journal in the field of innovation, Research Policy, published the special issue of LMT industries' innovation in 2009.

Based on the recently part of literature in LMT Industries' innovations theories, the paper discusses the three subjects: the characteristics, strategies, and policies in innovation. The purpose of this paper is to make policy makers and managers better understand innovation in the LMT Industries.

 

## The Characteristics of Innovation in LMT Industries

The expenditure of R&D in LMT industries is much less than it does in high- tech industries, which produces the distinct characteristics of innovation in LMT industries.

Pavitt classified industrial sectors into three main categories according to their technological characteristics: ‘‘supplier dominated’’, ‘‘production intensive’’ and ‘‘science based’’ [3]. The category of ‘‘supplier dominated’’ industries, refers to an important aspect of LMT industries and their innovation mode: technical change mainly comes from the suppliers of equipment. The characteristic of innovation processes typical of LMT can be determined by one of ‘‘key drives’’ –“supplier dominated’’.

Hirsch-Kreinsen H., a leader of the project-called POLIT, concluded the key LMT industries’ innovation drivers are technological paradigms and demand differentiations, which are based on the findings of case studies in 43 LMT industrial enterprises in nine EU countries that were conducted from mid-2003 to mid-2004 in the context of an international research project, as shown in Table 1.

Table 1 Stylized innovation modes

| | LMT | HMT (High- and medium technology) |
|---|---|---|
| Key drives | New technologies-market demand | Science and technology driven in combination with market demand |
| Typical strategies | Incremental-architectural | High relevance of radical innovations, main focus on product innovations |
| Size of enterprises | Mostly SMEs | Mostly large enterprises |
| Knowledge base | Internal: high relevance of practical knowledge | Internal: high relevance of codified knowledge in combination with practical knowledge |
| | External: codified knowledge | External: wide variety of sources for codified knowledge transcending sectorial boundaries |
| Company capabilities | Mostly management-based and unskilled workers; centralized competence base | Management, engineers, experts, skilled workers; broad competence base |
| Network relations | Cooperation with high-tech and specialized suppliers, consultants, etc., partly with customer, limited inclination to cooperate | Wide variety of external partners stemming from various societal sectors; intensive cooperation with external partner |

Source: Hirsch-Kreinsen, H., Low-Tech Innovations. Industry & Innovation, 2008. 15(1): p. 19-43.

The greatest differences between LMT and high-tech firms are also observed in the context of process innovations. The use of consultants, the hiring of personnel and external R&D are particularly significant external sources of innovation in LMT industries. In the case of product innovations, consultants are a significant factor for LMT firms, but not for high-tech firms [4].

Chen conducted the study of Taiwan’s machine tool (MT) industry and demonstrated the significance of informal learning activities in LMT industries and the possibility for latecomer clusters to climb the technological ladder through exploiting various local and global informal knowledge linkages [5].

## The Strategies of Innovation on LMT Industries

Different innovation strategies are understood as combinations of firms' preferences and capabilities for generating and diffusing varied kinds of innovation. They reflect contrasting approaches to risk management and institutionalized ways of dealing with technical and market uncertainty [7]. The

differences in innovation strategies are more or less closely linked with the companies' knowledge base, staff and organizational competences and the institutional environment. Because of the difference in LMT and high-tech industries, there also are differences in innovation strategies.

First of all, innovations of high-tech firms are nearly inevitably more technology oriented than those of LMT enterprises because of the former's running investments in R&D activities, making the role of technology more explicitly central to commercial success; that is, managerial decision making is necessarily linked to these structural conditions. In contrast, LMT enterprises need a broader variety of technology-oriented and non-technology-oriented strategy choices because of their well-established and highly competitive markets.

Second, following up on categories taken from innovation research, one can establish that the LMT innovation strategies move within a spectrum that is, on the one hand, bounded by the type ''incremental'' innovation and, on the other hand, by the type ''architectural'' innovation.

Both ''incremental'' innovation and ''architectural'' innovation thus differ fundamentally from radical innovations which transcend given technological concepts and which are in many (by no means all) cases regarded as typical for high-tech sectors [7], as shown in Table 2.

The distinctions between radical, incremental, and architectural innovations are matters of degree. Incremental innovation tends to reinforce the competitive positions of established firm(mostly LMT firms); the use of the term architectural Innovation is that use many existing core design concepts in a new architecture and that therefore have a more significant impact on the relationships between components than on the technologies of the components themselves, while radical innovation creates unmistakable challenges for established firms, since it destroys the usefulness of their existing capabilities

Table 2 A framework for defining innovation

| | | Core Concpets | |
|---|---|---|---|
| | | Reinforced | Overturned |
| Linkage between core concepts and components | Unchanged | Incremental innovation | Modular innovation |
| | Changed | Architectural innovation | Radical innovation |

Source: Henderson, R. M. and Clark, K. B. Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms, Administrative Science Quarterly, 35, pp. 9–30

We can also learn from Hirsch-Kreinsen H., who pointed that three typical innovation strategies can be distinguished, which center on the development of products, on customer oriented marketing concepts and on new process technologies (Table 3).

Table 3 The types of innovation strategies in LMT industries

| | Step-by-step | Customer oriented | Process specialization |
|---|---|---|---|
| Primary subject area | Incremental product development | Improving the market position; creating new markets new markets | Optimization of process technologies |
| Example | Supplier for the automotive industry | Fashion-oriented clothing and furniture industries | Paper manufacturing and food processing |
| Main conditions | Companies with relatively stable market segments | Broad range of various companies with turbulent market conditions | Companies with highly automated and integrated manufacturing processes |

Source: Hirsch-Kreinsen, H., Low-Tech Innovations. Industry & Innovation, 2008. 15(1): p. 19-43.

**The Policies and LMT Industries' Innovation**

As many countries evolve into a knowledge society, the ability to generate, use, diffuse and absorb new knowledge is increasingly viewed as critical to economic success and societal development. While the attention of policy makers, scholars and the public at large has been concentrated disproportionately on the 3 to 10 per cent of modern economies conventionally classified as 'high-tech', the importance of innovation activities in the LMT sectors that comprise the bulk of economic activity has tended to be overlooked. In this scenario LMT industries are deemed to offer severely limited prospects for future growth in comparison to high tech ones, and as a result, receive less explicit policy attention and support.

Regardless of the type of strategy, LMT companies emphasize negative factors such as high costs, particularly labor costs and taxes, and inflexible and restrictive state bureaucracies. This emphasis is not surprising given the intensive cost and competitive pressures that LMT enterprises face. There is an awareness among them of existing public promotion policies of technological innovations and state-aided extension or even start-up of factories as innovation-promoting conditions, but they frequently do not see these as helpful or relevant. Indeed these promotion policies often either fail to specify target LMT sectors or aim specifically at R&D and high-tech sectors. In general the specific concerns of low-tech industries are not included in public innovation support programmes. As a result LMT firms often refer to economic and innovation policy actors as'lacking awareness' of their needs. At best most innovation support programmes and measures promote the innovation ability of LMT companies only indirectly since they generally aim to improve the technological and economic conditions of industrial production.

So this focus on the contribution of low-tech industries to the innovativeness of industry as a whole is extremely important from a policy perspective at both national and regional levels, and indispensable to assessing the overall growth and performance possibilities of the national economy. An important point is the complementarity between enabling sectors (mostly high-tech) and mature industries (mostly LMT): innovation in enabling sectors influences the size of the market for output in mature sectors, but there is also a reverse influence in that the market size for enabling sectors hinges on the demand for innovation from mature sectors (Fig. 1).

It is ideal condition that policy makers recognize the importance of LMT industries and the characteristics of their innovations further produce suitable programmes and measures for LMT firms to promote the abilities of innovation and reduce innovation risks.

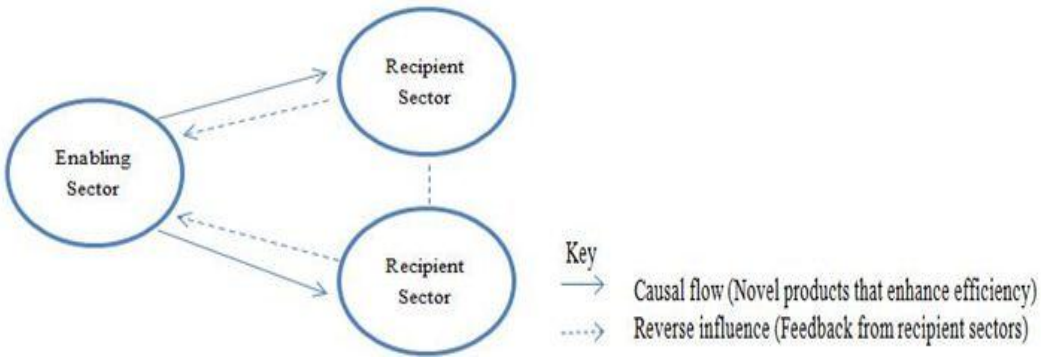


Figure 1. Enabling sector and recipient sector

Source: Pol, E., P. Carroll and P. Robertson, A New Typology for Economic Sectors with a view to Policy Implications. Economics of Innovation and New Technology, 2002. 11(1): p. 61 - 76.

## Conclusion

A brief review of literature about innovation in the LMT industries outlined in this paper has some research implications. Firstly, the findings from literature show that the characteristics of LMT industries' innovations are obviously difference from these of high-tech industries. Dominated suppliers, new technologies, market demand as well as external sources of innovation are perhaps the main drives for LMT industries' innovations. Secondly, incremental innovation and architectural innovation (or step-by-step, customer oriented, process specialization) are perhaps the suitable strategy choices in LMT industries. Finally, policy makers should pay more attention to the innovation in the LMT industries and develop the customized supportive policy to boost technical progress and upgrade the LMT industries.

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