Proceedings of the International Conference on Manufacturing Systems – ICMaS
Vol. 4, 2009, ISSN 1842-3183

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KNOWLEDGE-BASED ECONOMY MAIN REQUIREMENTS REGARDING THE DEFINITIONS AND THE MEASUREMENTS FOR INNOVATION AS A SYSTEM

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Abstract: *Because in the knowledge-based economy, innovation is playing a central role we consider necessary to better understand the complex processes of innovation at the macro-level, as dominant factors in national economy growth, and at the micro-level, within firm, as enchanting the firm's capacity to absorb and make use of new technology of all kinds. In this paper focusing on some main economical aspects of innovation, are presented the conceptual framework of innovation as systemic view, chain-link model as a way in which innovation is generated within the firm, and some proposals about the need to develop a new generation of indicators that can measure the innovation performance as well as other related outputs of knowledge-based economy.*

Key words: *innovation, knowledge-based economy, innovation system, innovation model.*

1. INTRODUCTION

We consider that the knowledge-based economy is an expression for describing trends in the most advanced economies, towards greater dependence on knowledge, information/data processing and high skill levels, in which an increasing need for ready access to all of these appears. Within the knowledge-based economy, innovation is seen to play a central role, and for that it is necessary that complex processes of innovation are better understood.

At macro-level, there is evidence that innovation is the dominant factor in national economic growth, and representing an international pattern of trade. At micro-level, inside the firm, research, development and innovation is seen as enhancing the firm's capacity to absorb and make use of new knowledge of all kinds, not only technological knowledge: ability to learn, ease to communicate, effective channels of information, skills transmissions and the accumulation of knowledge etc. According to [6], the innovative firm has a number of characteristics features which can be grouped into two major categories of skills:

- **Strategic skills**: long-term view, ability to identify and even anticipate market trends, also the desire and ability to collect, process and assimilate technological and economic information;
- **Organizational skills**: internal cooperation between operational departments, and external cooperation with public research, consultancies, customers and suppliers, involvement in the process of change and investment in human resources.

Innovation policy grew firstly around science and technology policy and absorbed significant aspects of industry policy. Science was seen as the driver, and all that governments needed was science policy. Innovation has brought out the importance of systems and led to a more integrated approach to have innovation-related policies.

The higher-level or systems view of innovation emphasizes the importance of transfer and diffusion of ideas, skills, knowledge, information and data, by using information and communication technologies, having an institutional framework, like "National System of Innovation" that can approach studies of innovating firm in the context of the external institutions, government policies, competitors, suppliers, customers, value systems, social and cultural practices that affect their operation.

System approaches to innovation shift the focus of policy, emphasizing on the connection between institutions, looking at interactive processes in the creation of knowledge and in the diffusion and application of knowledge.

2. CONCEPTUAL FRAMEWORK FOR INNOVATION SYSTEM

Collecting and systemizing data about innovation and factors that influence individual firm's behaviour, we can define four major categories:

- Factors that concern business enterprises (firms);
- Factors related to science and technology institutions;
- Factors related to transfer and absorption of technology, knowledge and skills;
- Factors related to environment of institutions, legal issues, macroeconomic settings etc.

These four categories can be presented and viewed as a map where the way in which policy leverage might be applied to business innovation, or when policy initiatives are elaborated.

While the emphasis in the literature is on national systems, it is understood that in many cases similar considerations apply at the local and transnational levels. In Fig. 1 these four general domains are presented as a map that can be associated with innovation policy system.

Framework conditions, as general institutional environment can be defined by:

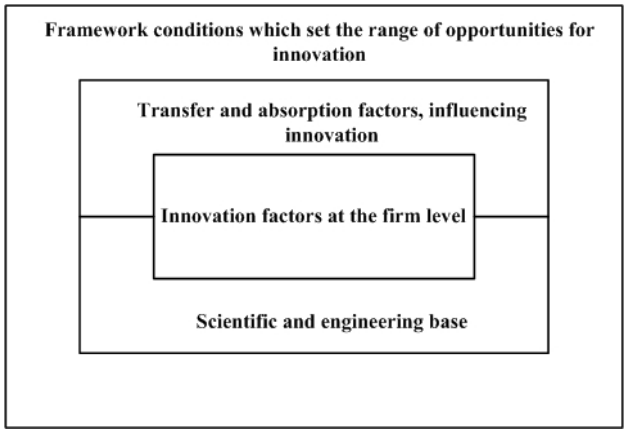

Fig. 1. A systemic view on innovation.

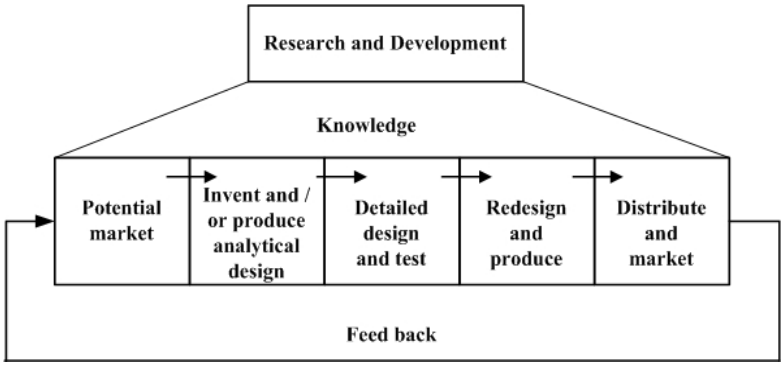

Fig. 2. The general chain-link model for innovation.

- Basic educational system for population;
- Communication infrastructure (roads, electronic communications);
- Financial institutions (access to venture capital);
- Legislative and macroeconomic settings (patent law, taxation, policies regarding interest ad exchange rates, tariffs and competitions;
- Market accessibility (establishment relations with customers) ;
- Industry structure and the competitive environment (supplier firms in complementary industry sectors).

Scientific and engineering base, as primary support for business innovation:

- University and specialised technical training system;
- Support system for basic research;
- Public and strategic R&D activities, as funding programs and institutions directed to pre-competitive R&D or generic technologies;
- Innovation support for SME (without their own in-house research).

Transfer factors, as human, social and cultural, mostly based around learning and education:

- Formal and informal linkage between firms, users and suppliers, regulatory agencies and research institutions etc.
- The presence of technological experts or receptors (individuals who keep the rhythm with new developments), that maintain and facilitate information flows of information/knowledge;
- International links and mobility for technologies and science experts;
- Access to public R&D capabilities;
- Spin-off company formation;
- Knowledge included in patents, the scientific journals and specialised press.

Innovation engine, as complex system of **factors** shaping innovation **at the firm level**, is the main recognising parameter of the firm importance for an innovative economy. The options available to a firm which wants to innovate (change its technological assets, capabilities and production performance) are of three kinds:

- Strategic: to have capability to make decisions about the types of markets to be created and the type of innovation that will be needed;
- R&D: basic and strategic research to extend the knowledge related to what is produced;
- Non-R&D that plays a major role in innovation and performance: identify new product concepts and production technology, needed human skills, process equipment for innovative work, or reorganisation of management systems.

As model for the way in which innovation is generated within firms and how it is influenced by external factors, we can recommend the approach named "chain-link model" [Kline and Rosenberg] presented in Fig. 2, which conceptualises innovation in terms of interaction between market opportunities and the firm's knowledge base and capabilities.

As key element in determining the success or failure of an innovation project is the extent to which firms manage to maintain effective links between phases of the innovation process: the model emphasises, for instance, the central importance of continuous interaction between

marketing and invention/design stages, by the using of feedback.

In the chain-link model, research is viewed not as a source of inventive ideas, but as a form of problem-solving, to be used at any point of the stages, when the firms are called on their knowledge base at that particular time, made up of part researches, technical and practical experience. Many research activities will be defined by innovative process and will derive from innovative ideas.

3. THE NEED FOR INDICATORS AND MEASUREMENTS

OECD recommended that there is a need for member states to collaborate to develop a new generation of indicators which can measure the innovation performance and other related output of a knowledge-based economy, as it was stated in the EC Green Paper.

As area for investigation for obtaining regular surveys of technological innovation, that should make it possible to measure the costs and benefits coming from innovative activities, we can nominate at least six elements:

- **Corporate strategies**, in connection with the development of products and markets;
- **The role of diffusion** of new developments throughout an economy;
- **The sources of information for innovation and obstacles** to innovation, that are significant for policy, since a good proportion of government measures are aimed at overcoming them;
- **Inputs to innovative**, integrating the R&D contribution with non-R&D inputs;
- **The role of public policy in industrial innovation**, by using questions on firms' perceptions of obstacles to innovation or the dependency of industrial applications on basic research results from universities and publicly founded centres/laboratories.
- **Innovation outputs**, defined as changes in terms of:
  - the attributes on performance characteristics of the product as a whole;
  - the components of the product which improve its efficiency.

Emphasizing the importance of the firm for innovation, as presented in Fig. 1, the scope of measurement must be discussed:

1. What do we want to measure, as technological product and process (TPP) innovations.
2. How should it be measured, choosing two main approach to collecting data on innovations:
   - The "subject approach" (the firm as a whole);
   - The "object approach" (a list of successful innovation).
3. Where should it be measured, as business enterprise sector if the focus is on the firm.

4. KNOWLEDGE AND INNOVATION AS TECHNOLOGICAL RESOURCES

Technological resources, as composed mix of traditional allocation of financial resources for physical, human and organizational capabilities, must add the knowledge and innovation, because from the interaction of these capabilities with the marketplace, and because the organizations can be competitive only by producing more financial resources

In the strategic management process, and the evaluation of strategic capabilities must provide the following information:

- The classification and measurement of current capabilities of the organization;
- The capabilities which should be developed and considered in competition;
- The area of vulnerability.

The organizations which survive and prosper over the long term are those which distinguish themselves in a way that generate continually resources which can be used to improve the current strategic capabilities, or to create new ones, by distinctive competence or competitive advantage, that are associated with knowledge and innovation (Fig. 3).

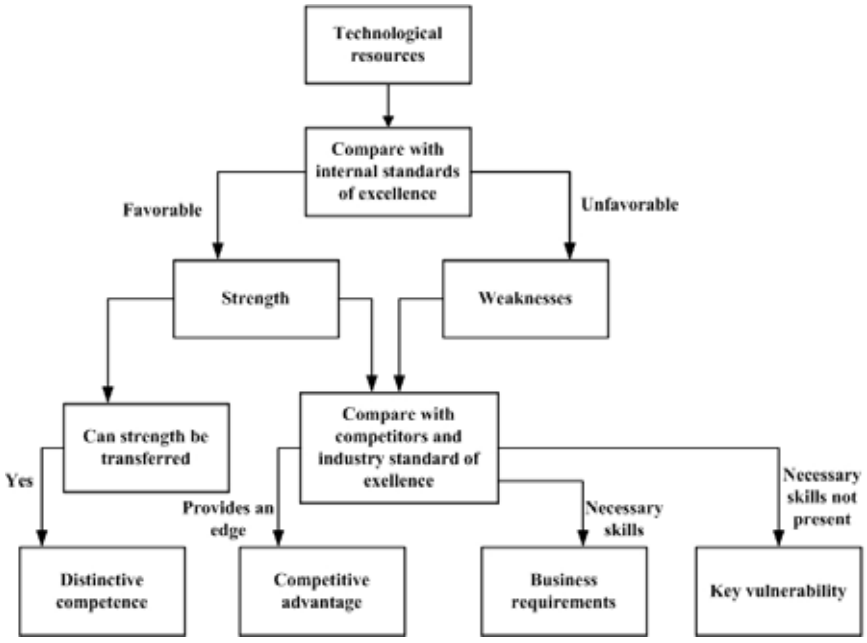

Fig. 3. Relationships and definitions in the use of technological resources.

The strengths that have been identified must be expressed in terms of competitive advantages and business requirements. Unique skills which can be transferred to other competitive setting are classified as distinctive competences.

The weaknesses must be examined for key areas of vulnerability when the organization is deficient in those areas. A weakness becomes a key vulnerability when it is a capability which is held by most competitors and is necessary for success in the competitive environment.

At the moment, industrial enterprises confront themselves with a series of problems due to the competitive environment enforced by market globalization and insufficient R&D capacity, difficulties met in usage of new technologies. All these factors lead to an economic and intellectual isolation of searching and defining solutions in order to diminish the consequences of these vulnerabilities. In this context, we consider that the Romanian companies should start to take into consideration and to actually implement knowledge and innovation as technological resources. But to use these resources for a new, innovative product done in an isolated enterprise could no longer be a valid option for the industrial engineering field without very large investments in technology, investments which are not always available in developing countries industries. A network of enterprises based on the integration and enhancement of CAD, CAM, CAE use, or CRM, ERP and SCM existing implementations could be more appropriate to provide a competitive solution.

5. CONCLUSIONS

The development and diffusion of new technologies are central to the growth of output and productivity, on the basis of innovation process, and their economic impact. The paper presents the concepts, definitions and an approach to improve understanding of the innovation process, as is presented in OECD countries. Particularly, "conceptual framework" and "chain-link model" on innovation are presented, in the context of information society, as knowledge-based society.

We also consider a very important issue that innovation on the global market implies networks based on the partnership between industrial enterprises and R&D entities. Even though there is not a general agreement on certain related terms and definitions, the concept of Virtual Enterprise (VE) is mostly associated with specific characteristics: a network of enterprises that constitute a temporary alliance, in order to share their costs, skills and resources, in supporting the necessary activities towards the exploitations of fast-changing opportunities, for product or service requests and competitiveness in a global market.

Based on this kind of VE architecture an innovative manufacturing enterprise should be viewed as a collection of interconnected industrial and research entities and the whole manufacturing system will be represented by the society of manufacturing agents, in which every agent will be doing specific tasks (design, planning, manufacturing, control and diagnosis, marketing etc.). The overall system will evolve out of their collective interactions.

There for, we consider important for innovative small enterprises to be able to develop their ability in involving themselves in international VE networks, where they can cover, using their skills, specific tasks of the projects proposed by the enterprises who are leading the field.

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