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MANAGEMENT OF THE TECHNOLOGY-BASED FIRMS IN THE DEVELOPING COUNTRIES

Досліджена сутність високотехнологічних компаній, їх характерні властивості та принципи операційного менеджменту. Наведена класифікація інновацій та моделей управління ними на прикладах відомих високотехнологічних компаній. Розглянуті варіанти розвитку високотехнологічних компаній в країнах, що розвиваються, а саме в Україні.

Ключеві слова: високотехнологічні компанії, операційний менеджмент, управління інноваціями та науково-дослідними роботами, технологічний менеджмент.

1. Introduction

Knowledge-based companies and technology-based firms are widely recognized as the driver of productivity and economic growth, shifting to a new focus on the role of information, technology and learning in economic performance. Especially critical role technology-based firms (TBFs) have in the developing countries that only searching its niche in the global market place. Competitive position of such companies can only be established provided thoroughly crystallized strategic focus and well planned operational management. For businesses in developing countries proper operation management is especially important considering strengthening of the knowledge-based competition in the global marketplace.

2. The object of research and its technological audit

In order to successfully manage technology based firms in the developing countries it is essential to understand definition, key features of TBFs, types of technological innovations, internal forces influencing corporate culture and TBF's efficiency. To suggest best approaches for small and large TBFs operation management in developing countries like Ukraine, knowledge-based companies in industrialized countries were analyzed. Examples of Henri Ford process innovations, Lockheed Martin, IBM, Apple and Boeing technology management achievements were discussed to help Ukrainian TBFs form its own competitive advantage by incorporating technological opportunities into its daily management practices.

3. The aim and objectives of research

The main aim of the article is to provide explicit analysis of the management techniques for TBFs in the developing countries.

To reach the aim such objectives were set and achieved:

1. Define key features of the technology-based firms.
2. Set forth constituencies and functions of the TBFs management.
3. Review types of innovations, its new and existing management models.
4. Identify main forces that form corporate culture necessary for TBFs development.

5. Offer approaches for managing large and small technology-based firms in the developing countries.

4. Literature review

Among the recent publications on the technology-based firms done by reputed scientists and practitioners, we should mention several ones. The studies [1, 2] consider changes in the financing environment for technology-based firms and issues for securing funding for the new TBFs. The other researches [3, 4] focus its attention upon development of technology and innovation models for the new TBFs and start-ups. Development of technology-based firms as spin-offs of the larger R&D projects in the defense and aerospace industries was investigated by author [5]. The study [6] investigates development of a newly created TBFs and conducive environment for their establishment and growth. Practical hints for building corporate culture that fosters innovation development were described in case studies [7, 8]. Statistical data showing influence of the TBF growth on the social and economic condition of the developing countries was gathered in research [9]. However, there is still lack of structural approach for management techniques that can be applied for TBFs in the developing countries.

5. Materials and methods of research

To achieve objectives that were set such research methods were applied: analysis, synthesis and generalization of existing scientific studies, analogies and comparison of the real life case studies were made. Such materials as latest scientific researches, publication of the international organizations and business reviews were used to derive to the research results.

6. Research results

For the developing countries such as Ukraine public interest for technology-based firms (TBFs) arose when several traditional industries such as aerospace, machine-building, mining and agriculture faced severe problems and new business models start emerging. TBF are considered as an answer to ongoing structural changes in the economy and an important source of new employment, technological change and innovation.

At the same time technology-based and knowledge based firms are concepts and words used freely, and often without a clear definition. Therefore, relevant definitions of the TBFs and its distinctive features will be summarized first.

According to one of the researches a technology-based firm is a company whose products or services depend on the application of scientific or technological skills or knowledge (whether it is a new application of advanced technology in a totally new product or service, or an application of present technology in an innovative manner) to a significant extent [1]. Often the technology component in the product or service provides a competitive edge above the existing ones.

The other one suggests that the term TBF refers to an organization with focus on creation, development and exploitation of technological innovation [3]. Technological innovations consist of the new products and processes or significant changes of products and processes. An innovation has been implemented if it has been introduced to the market (product innovation) or used within a production process (process innovation). Innovations, therefore, involve a series of scientific, technological, organizational, financial and commercial activities [10]. All industries generate or exploit new technology and knowledge to some extent, but some are more technology or knowledge – intensive than others.

There are distinctive features that describe technology-based company:

- it is a company that uses scientific and technological knowledge systematically and continuously to produce new goods or services with high added value [5];
- it mainly operates in strategic sectors, such as microelectronics, IT, mechanical engineering, biotechnology, medical devices, nanotechnology, etc. [6];
- it performs R&D in-house or in close cooperation with universities and research centers [6].

Thus, *technology-based firm can be defined as an organization that focuses on creation, development and exploitation of technological innovation and whose products or services depend on the application of scientific or technological skills or knowledge.*

Technology-based and knowledge-based firms are essentially hard to manage because they are based on innovation and permanently changing technology, often in a way that cannot be predicted. *Management of technology-based firm can be defined as a set of policies and practices that enable a company to build, maintain, and enhance its competitive advantage on the basis of proprietary knowledge and/or know-how.* Proper management for the technology-based firms means that all the basic organizational factors have appropriate alignment and can be managed together to significantly improve firm's effectiveness and its ability to achieve the goals. The factors, which act individually and interactively, are: the nature of a firm's innovations' process, the style of the management process: linear versus chain-linked model, the type of corporate culture.

Critical role in the management of the technology-based firm refer to the technology and innovation management that complement the overall strategy adopted by the firm [4]. Hence, *management of technology-based company strives to create competitive edge by incorporating technological opportunities into its daily management practices.*

Since technology management is identified as the core aspect of the TBF strategic management, its definition and main functions will be discussed more scrupulously.

Some sources identify such TM functions as «to plan, develop, and implement technological capabilities to shape and accomplish the strategic and operational objectives of an organization» [11]. Technology management is separate from research and development (R&D) management, which refers to the process by which a company runs its research laboratories and other operations for the creation of new technologies. *Technology management focuses on the intersection of technology and business, encompassing along with technology creation, its application, distribution and final impact.* It lies between R&D and new product development, with characteristics of the cyclical learning process of scientific discovery on the one hand and linear process of product development on the other hand [12].

Managing technological change requires handling such activities as invention and innovation. Invention is the development of a new idea that has useful applications while innovation refers to how an invention is brought into commercial usage [7]. As an example, Henry Ford did not invent the automobile instead he focused his innovation on creating a method by which cars could be manufactured and distributed cheaply to a large number of customers (mass production).

Four types of innovation that are described below provide better understanding for the practice of for TBFs' management (Table 1).

Table 1

Categories of innovation

Innovation category	Definition and key features
Incremental innovations	Use potential of established designs, and often strengthen the dominance of established firms. They improve the existing functional capabilities of a technology by means of small-scale improvements in the technology's value, adding attributes such as performance, safety, quality, and cost
Generational or next-generation technology innovations	Incremental innovations that lead to the creation of a new but not radically different system
Radical innovation	Commercialization of new products and technologies that have strong impact on the market, in terms of offering entirely new benefits, and the firm, in terms of its ability to create new businesses [11]. It introduces new concepts that depart significantly from past practices and help create products or processes based on a different set of engineering or scientific principles and often open up entirely new markets and potential applications. They provide new functional capabilities unavailable in previous versions of the product or service
Architectural innovations	Serve to spread out the radical-incremental classification of innovation and introduce the idea of changes in the way in which the components of a product or system are linked together

To properly manage company innovation two important steps are required. Initially, a project should be identified as a new product or as a technological innovation in order to apply proper development process. For the former traditional stage-gate process might be used, while for the later cyclical and iterative will be more appropriate.

After that managers need to identify what category an innovation can be referred to, since each type of innovation has its own challenges. In the aircraft industry, for example, an improvement in the construction of a wing

is an incremental innovation. Thus, such new technology can be introduced relatively easily and integrated with existing products.

An example of a generational innovation is the introduction of the Boeing 777, a new class of aircraft different from previous models. While similar in appearance to the 767 and its predecessor, the 777 introduced a complete new set of technologies and capabilities, demanding tremendous investment by Boeing and its business partners.

A radical innovation in an aircraft was the introduction of the jet engine, which completely changed the performance of an aircraft compared to propeller-driven airplanes. Finally, the concept of a flying machine as proposed by the Wright Brothers provides an example of the architectural innovation. Prior to the Wright brothers, the concept of mechanical flight had been invented and discussed. The Wright brothers actually developed and demonstrated a design that made human flight a reality.

Another form of technological change is invention, which is often identified with a single engineer or scientist working alone in a laboratory until he or she comes up with an idea that will change the world. In reality, industrial invention involves many people working together in a collaborative setting to create new technology. Innovation requires an even broader set of people, including manufacturing engineers, marketing and sales managers, procurement and financial managers, and business strategists. The methods for organizing this set of people to bring a new idea from the laboratory to the marketplace form the basis of the discipline of innovation management.

Innovation traditionally has been viewed as a linear process, which involves several stages in sequence: research, development, manufacturing, marketing, and ultimately, reaching the customer. However, this linear model of innovation has proven to be a misconception of the process. For example, problems during the manufacturing process may require researchers to go back and change the technology to facilitate production. The technology may reach the marketing stage and then only evidence lack of the market appeal. At the same time, managing innovation in a consecutive process would take a very long time, especially if each stage needs to perfect the technology before it can move on to the next stage.

An alternative to the linear model of innovation was offered by the expanded, *chain-linked* model of innovation. This model captures the interactions between the different stages of innovation in a more complete fashion. Some of the important aspects of innovation highlighted by this model are:

- technologies can move both forwards and backwards in the process, for example going back to the lab if further development is needed;
- downstream stages (such as marketing) can be consulted for input at earlier stages (such as design and test);
- R&D and engineering knowledge contributes to every stage in the innovation process;
- knowledge and skills needed for innovation are developed by communities of practitioners, not by individuals, and many of those communities exist outside of a particular firm (for example, in universities);
- users of technology can be an important source of ideas for improvements or even new innovations with substantial market potential;

- most firms create technology platforms, which are generic architectures that become the basis for a variety of technology-based products and services.

While the chain-linked model of innovation is more difficult to comprehend and analyze than the linear model, it eventually brings more outcomes as it closely follows innovations on their way from the laboratory to the marketplace.

Another innovation process suggested is new technology exploitation (NTE). It lies somewhere between new product development and «pure science» [12]. NTE is defined as «the testing of novel technical approaches specifically aimed at achieving a pre-defined result (target performance, cost reduction, etc.)» [12]. It is an iterative process that allows more cyclical learning process of scientific discovery, but clearly strives toward tangible goals and benefits.

One more technology management process, Strategic Technology Road Mapping (TRM) was discussed by Rachel Wells et al in Research Technology Management. Technology road mapping is both a process and a communication. TRM aims to «integrate technology issues considerations with the strategic business context, to identify those technologies that have the greatest potential to meet business goals, and to accelerate the transfer of technology into products» [8]. TRM makes use of visual aids to show links between R&D programs, capability targets, and requirements. It also seeks to help coordinate technology plans at a strategic level, and to help senior managers make better technology investment decisions.

Even though users and other external organizations are important sources of ideas for innovations, the internal organization of a company has the greatest impact on its capability for creating innovation. The ideal work environment for innovation does not exist. Instead, innovation is facilitated through the tension and balance between various conflicting but necessary forces that form corporate culture. Contrasting features of the TBF corporate culture are discussed below:

- Creativeness and discipline. Creative employees are needed to challenge existing assumptions and develop new and radical approaches for solving key problems. That inventiveness must be moderated by the discipline to capture the ideas generated by creative employees and by systematically determining which ideas can be turned into innovations, and how.
- Individualism and collaboration. Creativity is considered an individual feature, with some people being more naturally creative than others. But innovation is clearly a team effort, often involving hundreds or thousands of people. While companies should allow employees to express their individuality as a way to facilitate creative thought, that freedom must be placed in the context of the firm as a collaborative environment, where even the most brilliant individual has to work well with others for the company to succeed.
- Exploration and concentration. New ideas can come from a wide variety of sources, and it is hard to predict which paths of investigation will lead to the next breakthrough technology. Still, no firm has the resources to conduct research in every field at all times. The freedom to explore needs to be balanced by corporate decisions on what areas of study have the greatest chance to be paid off, and focusing research in those areas.

– Long-term and short-term. Radical innovations often take years to progress from concept to the actual product. For example, the digital computer invented in the 1950s had its roots in research conducted in the mid-1800s on logic and mathematics. Unfortunately, most firms cannot spend money on research that will only begin generating revenues in ten or twenty years. Most innovative activity in firms by necessity is focused on short-term improvements and technologies. Still, firms should not lose sight of long-term innovations, as those are the technologies that can damage existing market dominance.

There is a tendency to look for TBF among the new start-ups and small and medium-sized enterprises (SME). However, not all the start-ups refer to technology-based companies and not all the SME are inherently more innovative than large ones. There is a good example in the computer industry. In the 1980s the small firm Apple Computer appeared to turn out many more innovations than its large rival IBM. However, in the 1990s IBM used its huge resources to regain technological dominance in computers while Apple stepped back. During the 2000s, Apple came back strongly with innovative designs and technology, such as the iPod, and made big impact at the consumer behavior. Also during 2004, IBM decided to sell its personal computing division to focus on core business areas – information technology and software development.

Hence, it may be more accurate to say that small firms are better organized to handle specific types of innovation compared to large firms. Small firms have very streamlined organizational structures that have few managerial layers. Managers are multi-functional. Technical director might be in charge of business development as well as technical work. Project leaders may handle company-wide finances, human and material resources. This cross-disciplinary approach allows more flexibility and efficiency, which in turn is more favorable for radical innovation. The small firm model of organization is quite different from large established firms in which personnel usually have more narrow tasks while bureaucratic processes tend to suppress creativity and individual initiative.

Large companies lean towards production and distribution that are large-scale activities which do not accommodate rapid change. Therefore, the organizational structure of a large firm is quite matrix oriented: engineering teams each having their project, and a central laboratory supports research and development. Innovation is organized in a more linear fashion, and internal organization is built on discipline and focus. This type of organization is better suited to incremental innovation, since it can identify problems and focus large resources on solving them.

Hence, both small and large enterprises might be a technology-based firms, although each having its own strategy and organizational structures.

To overcome natural barriers and take advantage of all the innovations types there are several examples that both small and large TBFs should follow. Lockheed Martin, a large aerospace firm, was the originator of the Skunk Works, a lean, aggressive organization focused on R&D and rapid development of cutting-edge technologies. The group was kept completely isolated from the larger corporate organization, so that the engineers were set aside of all the overhead issues handled by other resources within the company. Besides the infrastructure of a large company

has to handle regulatory matters as well as financial support. Thus, a small firm and a Skunk Works of a large firm have lots of similar traits.

A small firm, in turn, can partner with a larger corporation to gain access to the resources and infrastructure needed to implement incremental as well as radical innovation. In the developed countries small firms tend to form technology-based strategic alliances as a source of financing [2]. The funds gained through the alliance with a larger firm are then invested in acquiring and developing tangible strategic assets such as patented technology, working capital, skills and know-how of the key managerial personnel. The large firm in the alliance receives marketing and intellectual property rights (IPRs) more often than equity or manufacturing rights in exchange for their capital investment. An alliance with a large firm can create a powerful combination that benefits both the small company and its established partner.

There are three key competencies that were identified critical to success on a three-year study of twelve large firms such as GE, Corning, IBM, and Shell Chemicals, among others:

- discovery-creation, recognition, elaboration, and articulation of opportunities;
- incubation-experimentation, technical, as well as for market learning, market creation, and matching the innovation with company strategy;
- acceleration-exploiting the technology, investing to build new business and infrastructure, responding to market opportunities [9].

However, authors of the study concluded that no one model works for all companies. Of the twelve companies that were investigated, four had very distinct but different approaches, each influenced by the company's corporate culture. But nearly all participants in the study acknowledged a need for cultural change within the organization before radical innovation could take place.

For developing countries essential push for internal changes is typically engendered by the structural economic changes [13]. In the beginning of 1990-s situation in Ukraine was quite typical for all the Post-Soviet countries with a very centralized economy heavily relying on the governmental funding for all the scientific and research programs. However, the need for commercialization and emphasis on serving real market demand forced lots of industries to change its form and scales. Large state-owned corporation in aerospace and machine-building industry were disappearing while giving the road to the smaller and medium-sized private enterprises with the strong market focus and desire to capitalize on its technological know-how in a very narrow niche. At the same time big state companies have been giving out non-core business activities and focusing its efforts on the innovation and R&D sphere. Slowly, but surely such enterprises are finding its place in the global sourcing chain.

Along with these trends, a new profession such the technology manager was emerging in early 2000-s. Defined as a generalist with many technology-based specializations and who possessed new managerial skills, techniques, and ways of thinking, technology managers knew company strategy and how technology could be used most effectively to support firm goals and objectives. Such discipline as technology management starts developing in Ukrainian universities adding cultural traits to its approaches and techniques.

There are lots of other preconditions for TBFs development in Ukraine such as strongly developed IT-sector with highly skilled specialists and IT-companies working globally. New start-ups are also being set up on the conceptually innovative ideas. The recent publication shows achievements of the local team of space engineers who worked on Mars Hooper project the winner of the NASA space APPs challenge [13]. Another way of strengthening TBFs of Ukrainian origin is to partner specialized machine-building, aerospace companies with local IT-sector. Products and services enhanced with the innovative and handfull software will find its market niche throughout the globe.

As a conclusion, it is worth admitting that management of technology-based companies continues to gain importance, impact, and attention in the developing countries. As technology becomes a pervasive force in the economic and social life of the country, thorough operation management of the TBFs helps to ensure that the development of new ideas and their applications are aimed at useful purposes, and that the benefits always outweigh the disruptions and difficulties that accompany innovation. Understanding of the TBF and its operation management principles is a prerequisite for all managers in the modern technology-intensive and technology-driven world of business.

7. SWOT-analysis of research results

Strength of the research is a structured layout of TBFs definition, its features and management principles. The study gives practical hints for large and small TBFs advance in Ukraine and other developing countries.

Weak point of the study is that outside forces for TBF development are not investigated and strategy formation for its long-term survivability is not suggested.

Opportunities for the future studies lay in expanding research objectives such as to formulate a strategy for TBFs in the developing countries. Also lifecycle of the new technology-based companies in the industrialized countries can be studied to develop wider range of operation management instruments at the different life stages.

Threatening point for the future studies will be a wide array of the influencing forces: like permanently changing technologies, market needs and managerial concepts that have to be aligned in the TBFs strategic and operations management.

8. Conclusions

1. Conducted analysis of existing studies on technology based and knowledge based firm allows to define it as an organization that focuses on creation, development and exploitation of technological innovation and whose products or services depend on the application of scientific or technological skills or knowledge. Its key features are ability to systematically and continuously produce new goods or services with high added value, performing R&D in-house or in close cooperation with universities and research centers, doing its business in strategic sectors, such as microelectronics, IT, mechanical engineering, biotechnology, medical devices, nanotechnology and others.

2. Definition of operations management for TBFs was identified as a set of policies and practices that enable a company to build, maintain, and enhance its competitive advantage on the basis of proprietary knowledge and/or

know-how. Critical role in the operations management of the TBF was referred to the technology and innovation management that complement the overall strategy adopted by the firm. Key function of the TBF's operation management was articulated as to align together all the basic organizational factors to significantly improve firm's effectiveness and its ability to achieve the goals.

3. Two types of technological changes such as invention and innovation were reviewed. Differences in the innovation varieties were identified and management approaches to each one were suggested. Advantages of the chain-linked versus liners model to the innovation management were described.

4. Contrasting features of the TBFs corporate culture were discussed to show its impact on company's growth.

5. Different approaches for managing large and small technology-based firms were offered as well as possible solutions for strengthening Ukrainian TBFs position at the global marketplace were reviewed.

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**УПРАВЛЕНИЕ ВЫСОКОТЕХНОЛОГИЧЕСКИМИ КОМПАНИЯМИ
В РАЗВИВАЮЩИХСЯ СТРАНАХ**

Исследована сущность высокотехнологичных компаний, их характерные особенности и принципы операционного менеджмента. Приведена классификация инноваций и моделей управления ими на примерах известных высокотехнологических компаний. Рассмотрены варианты развития высокотехнологических компаний в развивающихся странах, а именно в Украине.

Ключевые слова: высокотехнологические компании, операционный менеджмент, управление инновациями и научно-исследовательскими работами, технологический менеджмент.

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**ИССЛЕДОВАНИЕ УСЛОВИЙ ПОВЫШЕНИЯ
КОНКУРЕНТОСПОСОБНОСТИ СНЕКОВОЙ
ПРОДУКЦИИ ПРЕДПРИЯТИЙ ПИЩЕВОЙ
ОТРАСЛИ**

Проведено дослідження умов формування конкуренції в сегменті снекової продукції підприємств харчової промисловості. Проаналізована структура і динаміка споживання продукції по групах товарів. Виділені ключові тенденції розвитку ринку в умовах економічного спаду. Визначили лідерів галузі в розрізі товарних груп, а також характер конкуренції між ними. На основі аналітичної і статистичної інформації про діяльність провідних виробників визначені пріоритетні напрями розвитку снекового ринку з урахування впливу ключових факторів конкурентоспособності.

Ключевые слова: рынок снеков, конкуренция, структура потребления, динамика экспорта, сезонные колебания спроса, факторы конкурентоспособности.

1. Введение

Под влиянием трансформационных процессов, вызванных интеграцией Украины в международную экономическую систему и внутренними экономико-политическими преобразованиями, происходят системные изменения в отраслевой структуре экономики, вывода предприятия агросектора на ключевые позиции. Природные, технико-технологические, историко-демографические условия развития этой отрасли, а особенно сектора пищевой промышленности, благоприятствуют росту капитализации предприятий и обеспечивают их высокий экспортный потенциал.

Новые вызовы, которые ставит современная бизнес-среда перед украинскими производителями, способствуют активному поиску конкурентных преимуществ для обеспечения устойчивого развития предприятий в условиях снижения темпов роста экономики. Для обеспечения притока инвестиций в наиболее перспективные отрасли необходимо всестороннее исследование условий формирования конкурентной среды и выявление тенденций развития рынков.

**2. Объект исследования
и его технологический аудит**

Объектом исследования является рынок снековой продукции предприятий пищевой отрасли в Украине. Дан-

ный рынок является одним из наиболее перспективных и быстрорастущих рынков мировой экономики, и у производителей Украины есть значительный потенциал для развития в данной сфере. По оценкам экспертов [1–5], мировое потребление снековой продукции существенно отличается от уровня потребления на внутреннем рынке. Так, среднестатистический житель США потребляет около 10 кг снековой продукции в год [2], в Европе этот показатель равен 5–6 кг [4], а в Украине — только 1,5 кг [5], что свидетельствует о высоком потенциале роста потребительского рынка в среднесрочном периоде.

Для выявления ключевых факторов конкурентоспособности снековой продукции проведен анализ конкуренции в отрасли, выявлен экспортно-импортный потенциал рынка, сформирован состав ключевых игроков и лидеров рынка.

Проблемы развития отрасли, связанные с кризисными явлениями в экономике Украины последних лет, сопоставлены с возможностями и перспективами роста, что способствует повышению конкурентоспособности производителей снековой продукции на внутреннем и внешних рынках.

3. Цель и задачи исследования

Цель исследования состоит в проведении анализа конкурентной среды на рынке снековой продукции в условиях выхода экономики Украины из кризиса.