

High Technology Company – Concept, Nature, Characteristics

AGNIESZKA ZAKRZEWSKA-BIELAWSKA

Department of Management

Technical University of Lodz

ul. Piotrkowska 266, Lodz 90-924 POLAND

a_bielawka@poczta.onet.pl

Abstract: The importance of existence of a strong and dynamic high technology companies sector in the current world economy is enormous as it largely influences the potential for global competitiveness of individual nations or regions. In the developed, post-industrial economies the high technology companies sector is commonly regarded as the area with the largest use of and dependence on the so called special means of production – knowledge and human resources. These means are constantly created, which enables not only competition among individual companies but also has a positive effect on the surroundings (traditional industries, level of science, etc.). High technology sector also requires continuous and intense innovative activities as well as large research and development investments. Most of the previous studies of the high technology sector have focused on the issues related to methodology of measuring the research and development activities and its results, the amounts, structure and sources of financing, institutional solutions and the role of the state in stimulating the scientific and technological progress as well as on the issues of technological advancement in a wider context of innovativeness. However, there have been few studies of high technology companies' functioning and management. This article is an attempt to define the concept of a high tech company and identify its characteristics in comparison to a traditional, industrial enterprise, considering the basic organisation units. It has been shown that every HT company, apart from the fact of operating in high technology sector, is an innovative enterprise based on knowledge and using modern IT technology.

Key-Words: high technology sector, company, innovation, knowledge, learning organisation, information technology

1. Introduction

The increase of importance of high tech industries and development of high tech companies has been observed for several years. Such companies, while effectively using knowledge, are the source of inventions and innovation. The expenses for research and development activities in the high tech sector, their results in the form of technologically advanced products and their application in production of traditional goods determine performance of the whole economy. High tech sector is difficult to define due to the fact that the majority of new technologies cross borders of traditionally divided industries. As there is no unambiguous and commonly approved definition, the concepts of a sector as well as a high tech company become a complex and varied issue. **This article is an attempt to define the nature and characteristics of a high tech company** on the basis of the high tech sector specific features as well as the characteristics of an innovative company, based on knowledge and extensive use of modern IT technology.

2. Specificity of high tech sector

When discussing the problem of definition of high tech sector, the following question arises: is the sector a

producer, a creator of advanced technology or rather a user, commonly applying such technology?

According to the National Science Foundation, there is no single preferred method for identifying high technology industries. It is most frequently assumed that high technology sector represents the industries, which are generated at the meeting point of science and industry, and which are based on processing of scientific research results in industry. [9, 4] OECD (Organisation for Economic Co-Operation and Development) methodology is applied for the EU countries statistics of economic sectors, based on sectoral approach by economic sectors, ISIC/NACE and product approach by product groups, SITC) [16, 22, 23]. In both approaches, the main factor deciding whether a given sector or product is perceived as a high technology one is assessment of R&D expenses intensity. High technology is a relative category in such an approach. It encompasses sectors or products, which fulfil certain quantitative criteria in a given period, contrary to such sectors or products, which do not fulfil such criteria. It should be noticed, however, that the literature on the subject enumerates, apart from the R&D intensity indexes, a number of other criteria,

¹ This article was finance from the science-dedicated resources in the years 2008-2010 as a research project of Ministry of Science and Higher Education No. N N115 128434

which enable identification of high technology sectors, e.g. involvement of science and technical personnel, the number of obtained patent rights or signed licence agreements [23].

The horizontal approach perceives high technology sector from the science perspective [33]. For example biotechnology, defined as a high tech sector, is characterised by a high share of R&D expenses on one hand, but on the other hand, its commercial applications can be found in many other industries, both low technology (e.g. bakery) and high technology (e.g. pharmaceutical industry). This approach emphasises the technologies, which have become the basis for a brand new economic infrastructure. These are often basic technologies, with the possibility of long-term and diverse development potential. This approach, similar to the high technology definition in Japan [33], identifies technology bundles rather than an independent, isolated technology, even if it displays high R&D expenditure intensity. Moreover, new technologies differ from the traditional ones due to the presence of stochastic, continuous and abstract events [32]. Highly advanced technology does not require efficiency management, which involves productivity, quality and motivation improvements, but it changes managers into the so called change catalysers, whose aim is to activate and support the introduced improvements and self-management related to hierarchy dispersion and the use of organisational and leadership skills [34, 15]. However, it seems reasonable to point out key features of the sector, which make it possible to differentiate the sector from the less technologically advanced industries. The following features should be mentioned:

- high demand for scientific research and intensity of R&D expenditure,
- high level of innovativeness,
- fast diffusion of technological innovations,
- fast process of obsolescence of the prepared products and technologies,
- high level of employment of scientific and technical personnel,
- high capital expenditure and high rotation level of technical equipment, replaced by more modern and innovative devices,
- high investment risk and fast process of the investment devaluation,
- intense, strategic domestic and international cooperation with other high technology enterprises and scientific and research centres,
- implication of technical knowledge in the form of numerous patents and licences,
- increasing competition in international trade [23, 20].

Considering the above mentioned features, the most typical examples of high technology sectors are aerospace equipment sector, computers, telecommunication devices and technologies, advanced technologies sector based on CAM, CAD, CIM, optical equipment, biotechnological sector, pharmaceutical industry, laser devices, nuclear sector, power and technical machines and equipment, etc. [23]. It should, however, be emphasised that defining limits and size of the sector is a challenge and the issue of defining a high technology sector is a complex, varied and in a sense open to the new, more precise approaches and classifications, which will certainly emerge in future.

Therefore, defining an enterprise as a company operating in a high technology sector is not sufficient and requires a wider approach. Such companies should be the source of new knowledge, inventions and innovations. It can be assumed that a high technology company should have the features of an innovative and knowledge-based enterprise.

3. A HT company as an innovative enterprise

An innovative company, according to Oslo methodology², is an enterprise, which during a given period (most often three years) introduced into the market at least one technical innovation (a new or considerably improved product or a new or considerably improved technological process). It is a company, which offers high capacity for creation, implementation and popularisation of various innovations [24]. J. Schumpeter created the classical theory of innovation, which states that innovation is production and distribution of new products and services, application of new production technologies, identification and control of new sales markets, identification and use of the new raw materials purchasing sources as well as creating new organization solutions in economy [27].

Currently, two approaches in innovations interpretation dominate. The first emphasises the factual (result) type of innovations, which include changes in production leading, in turn, to generation of new product [30]. Another approach underlines the activity (process) importance of innovations, which include all processes of creative thinking, aiming at application and use of improved solutions in technology, organisation and social life [18].

An innovative company is able to create and absorb innovations, is creative and continuously adapts to the

² The Oslo methodology defines methodological guidelines for statistical research of technical innovations (innovative activities), with the application of the so called subject method (the research subject is innovative activity and innovative behaviours of a company as a whole) in the companies' industry sector and in the so called market services sector. The method was prepared by OECD experts and published in an international methodology handbook referred to as Oslo Manual.

changes occurring in the environment [10] and aims at achieving the technological leadership position [4]. Table 1. contains the most important characteristics of an innovative company.

Table 1. Characteristics of an innovative company

An innovative company	Characteristics
	implementing Research and Development activities on a large scale and dedicating large financial resources for R&D
	the ability to continuously generate innovations, creativity
	regular implementation of new scientific and technical solutions
	continuous introduction of innovations to the market (high capacity for creating but also implementing innovations)
	high capacity to adapt outsourced innovations (purchasing designs of new products or technologies)
	relatively high share of new products and/or technologies in total volume of production or services of the company
	ability to predict future and forward thinking, flexibility
	ability to use the company innovative potential in order to maintain good competitive edge, based on key competences
	effective use of team work potential and passion for diversity

Source: [2, 4, 10, 12]

Moreover, innovative companies are much more dynamic than others and show 1/3 higher productivity (measured by the proportion of the added value to the number of employees) in comparison to non-innovative companies, larger size and, in consequence, relatively larger addend value, higher turnover by approximately 1/5 per one employee, two times higher investment expenditure per one employee and investment rate (versus addend value) sometimes as high as 40%, very high exports dynamics (by approximately 7–15% more than non-innovative companies) and high export rate (over 50%) (measured by the proportion of exports to total turnover) [23].

The presented characteristics of an innovative company reflect many features of a high technology company. However, due to the broad interpretation of innovation and the sectoral limitation regarding R&D expenditure in revenue (from 8 to 15% in high technology sector), it can be stated that **every high technology company is an innovative one, however, not every innovative company is a high technology one.**

4. A HT company as a knowledge-based enterprise

A knowledge-based company manages knowledge in a conscious and systematic way. For such a company, knowledge is a strategic asset. That is why the company attempts to manage it in a most effective way. The literature on knowledge management provides many definitions of knowledge, which is due to its various interpretations. For example, knowledge is the information in context together with understanding of the way to use it [5, 25]; it is the effect of the use of information and experience in a process of thinking [28]; it is a coherent mix of the obtained information, experience and the approved system of values [8].

Despite the differences in perception of knowledge, one may emphasise its distinctive features, such as exclusivity (increases the potential competitive edge of a company), relativity and ambiguity (can be interpreted in various ways by different persons), dynamism (it can be corrected, processed, improved; it can extend in the process of use application), value (it can increase with extender use and can multiply a company's market value), applicability (it can be applied in different areas when solving current and future problems), ageing (it gets obsolete quite fast), resistance (it is impossible to copy or replace easily), materiality (it is manifested in products and services), codification (it is structured in technological and organisation documentation as well as in databases) and easy to learn (ability to be absorbed by a large group of employees) [13, 17, 21, 29].

Knowledge is certainly the result of observation, experience and the learning process. The mechanism of positive feedback, i.e. the progressing accumulation of knowledge, meaning its effective growth, is present in the learning process. The organisation, which learns is an intelligent one, capable of self-reflection [1].

The knowledge-based companies can manage knowledge, develop and use intellectual resources; they can also collaborate effectively for their own and others benefit, within the framework of established creative networks of partnerships (e.g. Silicon Valley). Table 2. contains the most important characteristics of a knowledge-based company.

High technology companies, as organisations with high demand for scientific input, high level of education among personnel and management, which create, collect and distribute new knowledge can be defined as knowledge-based companies. Focusing on the continuous process of acquiring, development and application of knowledge makes such companies intelligent and learning organisations. However, also in this case, due to the specific nature of high technology sector, it seems justified to state, that **every HT company is a knowledge-based and learning**

enterprise; however, not every knowledge-based and learning company is a HT one.

Table 2. Characteristics of a knowledge-based company

Characteristics	
A knowledge-based company	it focuses on designing and applying technology, information and knowledge; it creates, capitalises and distributes new knowledge and skills
	it negates stereotypes and continuously adjust its operation methods to current situation, modifies the internal organisation
	the dominating assets are knowledge and intellectual resources, which are continuously developed and invested in
	it uses experience to create new knowledge and control the acquired skills; the growing and updated experience allows to master new concepts and experimentation
	high tolerance of uncertainty, the atmosphere of creative chaos, extraordinary events seen as the source of inspiration
	the main organisation values are: quality, customer service, variety, innovativeness, relationships
	collective learning and sharing of knowledge, openness to criticism
	close cooperation with partners based on trust; involving customers in cooperation
	building competitive advantage on the basis of unique competences
	high changeability and mobility of the organisation participants thanks to rotation; harmonious cooperation
	structures with high dynamics of change, supporting learning; high autonomy of employees backed with knowledge and professionalism

Source: [11, 17, 21, 31]

5. An HT company as an enterprise using modern information technology

Another factor, which determines the concept of a high technology company, is modern information technology. It is simultaneously the basis of the knowledge management system. Information technology (IT) integrates different technologies (hardware, software, telecommunication, teleinformatics) and used to acquire, select, analyse, process, store, manage and transfer of information to others [9]. A high technology company should use new information technologies, as they increase its efficiency, productivity and flexibility as well as lower costs [19]. Simultaneously, IT supports improvement of

organisation structure flexibility by its levelling (often by reducing middle level managerial personnel) [7].

The advanced information technologies support research and implementation works, which helps reduce the design stage and products introduction to market period [19]. Considering the above, the appropriate information systems should be established in high tech companies, in order to acquire knowledge from various sources, codify and create new knowledge and provide opportunity to share it. Such systems should be characterised by the factors, which are presented in Table 3.

Table 3. Characteristics of management supporting IT systems

Characteristics	
Management support information system	isomorphism (correspondence of forms) – means delivering information on three levels of responsibility, such as operational control, managerial control and strategic planning
	structural and functional flexibility – allows to adapt hardware and software solutions within technical and functional structure to the needs of the company during the system implementation and makes it possible to modify and dynamically adjust with variable requirements and needs generated by the environment.
	thematic data storage – data on one topic generated by different systems are stored in one location and their update is connected with modification and adding information
	data analysis and knowledge extraction – discovering interrelations, generalisations of data, classification and grouping, discovering similarities
	security – access to information is secured and depends on the user authorisation level
	subscription – a user automatically and regularly receives the self-selected information
	support of working teams operation – joint publications, work with documents, a discussion list, on-line conferences

Source: [6, 19, 26]

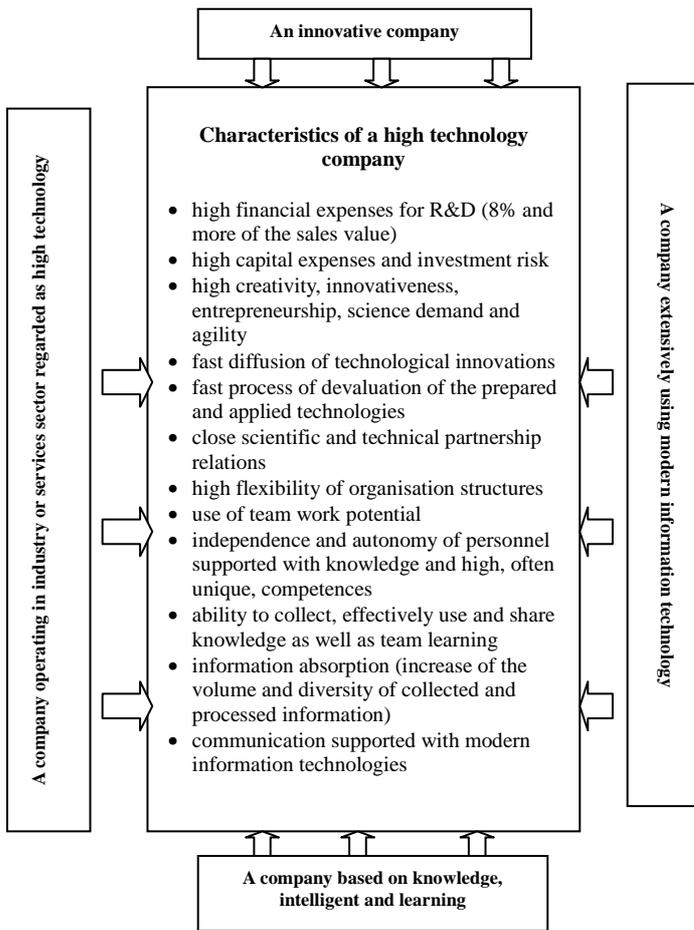
Another aspect in this area, especially in building a knowledge management system, is the selection of appropriate IT tools. The most important tools are business intelligence, groupware/collaboration, workflow/business process management – BPM, customer relationship management – CRM, document management/content management, etc.

Due to the important role of information systems in knowledge management and decision support systems, creating innovations and supporting research and development activity as well as considering the fact that high technology sector has high demand for science and

information, it seems right to state, that **every high technology company widely uses modern information technology, however, not every company, which uses advanced information technology is a high technology company.**

6. Conclusion

In the light of previous considerations, a high technology company was defined as a business enterprise operating on the border of economy and science, in the sector regarded as high technology and/or making products classified as high technology items. The company runs research and development activity and combines the features of an innovative and knowledge-based company. It uses to a large extent modern information technology and is open to cooperation with environment, creating various network connections and clusters with other organisations. A high technology company defined in this way has certain characteristics, which are quite different than a traditional production or service enterprise. The characteristic features of a HT company are presented in Fig. 1 and a comparison between an industrial company and a HT company, considering a statistical approach to their main elements is included in Table 4.



Source: Own study

Table 4 A HT company versus a traditional, industrial company

	Traditional industrial company	A high technology (HT) company
Objectives and strategy	Gaining profits	Return of expenses in a very short time due to dynamic changes in technology
	Often passive or reactive strategy versus changes in environment	Proactive, anticipating changes in environment, especially opportunities and chances
	The lack or rare cooperation with other organisations, focus on producing material goods	Intense, strategic domestic and international cooperation, especially with R&D centres
	Building competitive advantage on the basis of capital and financial assets	Building competitive advantage on the basis of knowledge, intellectual capital and innovations
	Investing mainly in tangible assets	Investing in tangible and intangible assets with high risk factor
Production and technology	Mass and large series production of goods for mass consumers, long production batches, few patents, rare inventions	Production of goods involving resources of modern science and technology for an intelligent customer, short production batches, numerous patents and licences, continuous innovativeness
	Large capital demand	Large scientific input demand
	Specialised plants	Variable processes plants
	Long changeover time of machines and technical equipment	High level of rotation of technical equipment; replacing with more modern and innovative devices
People	Limited integration of production process (focus on partial processes)	High integration of production process (focus on making an innovative product)
	High employment of production personnel	High employment of science and technical personnel as well as persons with knowledge
	Individual work or in permanently organised teams	Team work with much mobility and diversity as well as temporary participation
	Low creativity of personnel, heteronomy and frequent lack of independence in problem solving	High creativity of personnel, ability of creative thinking and autonomy; independent problem solving
	Little training and skills improvement	Continuous training, improving qualifications and development of personnel; team learning
Organisation structure	Disciplinary measures for mistakes	Learning from mistakes
	Traditional, focused on the functions of a company	Cooperation networks of self-managing entities, focused on processes
	Hierarchy, monolithic, developed	Weaker hierarchy links, domination of horizontal connections with virtual features
	Fixed and structured organisation	High dynamics of change and flexible organisation
Management	High centralisation	High decentralisation
	Formalised, mainly vertical communication	Communication by means of advanced information Technologies, vertical and horizontal, often informal
	“Control-focused” management	“Support-focused” management
	Holding on to stereotypes	Negating stereotypes
	Making decisions frequently on the basis of intuition or within fixed procedures	Making decisions on the basis of empirical data
Management	High position of managers	Large autonomy of employees, based on competences
	Avoiding uncertainty	Acceptance of uncertainty and permanent change

A HT company is a business unit of a new era, the era of knowledge and innovation, which makes it an innovative, intelligent and learning enterprise.

References:

- [1] Argyris Ch., On Organizational Learning, Blackwell Publishing, Oxford 2001
- [2] Aydogan E., Innovation Policies, Business Creation and Economic Development. A Comparative Approach, Springer Science – Business Media LLC, 2009
- [3] Bernasconi M., Harris S., Moensted M., High tech entrepreneurship. Managing innovation, variety and uncertainty, Routledge Taylor & Francis Group, London, New York, 2006
- [4] Bessant J., High Involvement Innovation, John Wiley & Sons Ltd, Chichester 2003
- [5] Brooking A., Corporate Memory. Strategies for Knowledge Memory, International Thomas Business Press, London, 1999
- [6] Chung – Seng L., Smith J., Rakesh M.R., Topol B., Distributed Application Service for Internet Information Portal, Institute of Electrical and Electronics Engineers Symposium on Circuits and Systems, May 28 -31, 2000
- [7] Daft R.L., Understanding the Theory and Design of Organizations, Thomson South – Western, 2007
- [8] Davenport T.H., Prusak L., Working Knowledge, Harvard Business School Press, Boston 1998
- [9] Davis Ch. K., Technologies & methodologies for evaluating information technology in business, Hershey, PA : IRM Press, 2003
- [10] Drucker Peter F., Innovation and entrepreneurship: practice and principles, The Classic Drucker Collection, Elsevier, 2007
- [11] Easterby – Smith M., Lyles M.A. (eds.), Handbook of Organizational Learning and Knowledge management, Blackwell Publishing Ltd., 2003
- [12] Elttilie J.E., Managing Innovation. New technology, new products, and new services in global economy, Elsevier Butterworth Heinemann, Oxford 2006
- [13] Evans Ch., Managing for Knowledge. HR's Strategic Role, Butterworth – Heinemann, 2003
- [14] Grudzewski W.M., Hejduk I.K., Zarządzanie technologiami. Zaawansowane technologie i wyzwanie ich komercjalizacji, Difin, Warszawa 2008 (in polish)
- [15] Hatch M.J., Organization theory: Modern, symbolic, and postmodern perspectives, Oxford University Press, 1997
- [16] High-technology manufacturing and knowledge intensive services sectors: Economic, Science & Technology and Employment statistics, ec.europa.eu/eurostat.
- [17] Jashapara A., Knowledge Management: An Integrated Approach, Pearson Education Limited, 2004
- [18] Kotler Ph., Marketing management, Prentice Hall, Inc, 1994
- [19] Maier R., Knowledge Management Systems. Information and Communication Technologies for Knowledge management, Springer- Verlag Berlin, Heidelberg, 2002
- [20] Matusiak K., High tech, Innowacje i transfer technologii. Słownik pojęć, PARP, Warszawa 2005 (in polish)
- [21] Mikuła B., Organizacje oparte na wiedzy, Wydawnictwo Akademii Ekonomicznej w Krakowie, Krakow 2006 (in polish)
- [22] NewCronos, High-tech statistics – progress report, Doc.Eurostat/F4/STI/2009/11, Working Group Meeting on Statistics on Science, Technology and Innovation, Luxembourg 2009.
- [23] OECD Science, Technology and Industry Scoreboard 2009, www.oecd.org
- [24] Oslo Manual. Guidelines for collecting and interpreting innovation data (Third edition) <http://www.oecd.org/dataoecd/35/61/236758>
- [25] Probst G., Raub S., Romhardt K, Knowledge management in organizations, Oficyna Ekonomiczna, Krakow 2002 (in polish)
- [26] Roth C., Portal Infrastructure Impact Analysis, Research paper WCS, Vol. 1, No. 4 MWTA Group Inc., July 2002
- [27] Schumpeter J., The Theory of Economic Development, Cambridge, MA: Harvard University Press, 1934
- [28] Soo Ch., Devinney T., Midgley D., Deering A., Knowledge Management: Philosophy, Processes, and Pitfalls, California Management Review, No. 4 / 2002
- [29] Srikantiah T.K., Koenig M.E.D., Knowledge Management in Practice. Connections and Context, American Society for Information Science and Technology 2008
- [30] Tidd J., Bessant J., Pavitt K, Managing innovation. Integrating technological, market and organizational change, John Wiley & Sons Ltd, 2005
- [31] Tuomi I., Corporate Knowledge. Theory and Practice of Intelligent Organizations, Metaxis Helsinki, 1999
- [32] Weick K.E., Technology as Equivoque: Sensemaking in New Technologies, [in:] Goodman P.S., Sproull L.S. [eds.], Technology and Organizations, Jossey – Bass, San Francisco 1990
- [33] Wojnicka E., P. Klimczak P., Wojnicka M., Dąbkowski J., Perspektywy rozwoju małych i średnich przedsiębiorstw wysokich technologii w Polsce do 2020 roku, PARP, Warszawa 2006 (in polish)
- [34] Zelny M., High Technology Management [in:] H. Noori, Radford R.E. (eds.), Readings and Casus in the Management of the New Technology: An Operations Perspective, Prentice Hall, Engelwood Cliffs 1990,