BUSINESS ENVIRONMENT FACTORS DETERMINING THE SELECTION OF TIME FOR THE IMPLEMENTATION OF NEW TECHNOLOGIES IN LITHUANIAN INDUSTRIAL ENTERPRISES

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crossref http://dx.doi.org/10.5755/j01.em.18.4.5347

Abstract

Purpose *– to evaluate business environment factors of the Lithuanian industrial enterprises, conditioning the selection of time to implement new technologies.*

Methodology. *The general research methods applied in this article are the systemic comparative and structural analysis of the scientific literature, statistical data analysis, and schematic modelling. Empirical research is based on qualitative methodological approach: method of expert evaluation on the basis of a questionnaire survey and rating coefficients of factors' weight.*

Results. *Obtained results revealed that in the recent years, the connection of industrial progress, organizational changes and economic competitiveness has increased. Due to this, the development of new technologies and their implementation in the industry has become one of the most significant factors of Lithuanian economic strategy, determining the speed and results of the economic-social development. Therefore, the evaluation of internal resources of the enterprise as well as the capacity, business environment market and finally the selection of time for the implementation of the new technology serve as the basis for achieving the competitive advantage and successful performance of the enterprise. This paper presents the findings of the expert evaluation, which aimed to investigate the most important external business environment factors determining the selection of time for the implementation of new technologies in the Lithuanian industrial enterprises. Considering the results of the expert evaluation, a summarizing conclusion has been made that the most essential factors of external business environment are as follows: the level of market concentration, the change of consumer needs and product price in sales market.*

The type of the article: *Research report.*

Keywords: *new technology, time selection of technology implementation, business environment factors.*

JEL Classification: *O12, O14, O33.*

1. Introduction

The Lithuanian industry sector has been facing a strongly cost-driven and production efficiency requiring environment under the conditions of global competition in the recent years. Environmental progress has also been a significant driver for industry, as companies have aimed to cut costs by making more efficient use of energy and resources. However, strict environmental regulation has also lead to the fast adoption of radically new manufacturing approaches in some regions and concentration of manufacturing activities in industrial clusters to retain production. Increasingly, industry is confronted with the challenge of moving toward a more sustainable path of production and consumption while increasing global competitiveness. In order to cope with intense competition, industry has vigorously pursued further increases in productivity and reduction in time-to-market. The production system has moved towards customer tailored production and manufacturers focus on customisation and individualisation of products.

Within this currently complex and rapidly changing business environment, the tendencies of

technological development and implementation in the industry are more often emphasized in the scientific literature (Chesbrough *et al.*, 2008; Lynch *et al.*, 2012; Özdemir & Şehitoğlu, 2013). Technology and its management are essential for meeting these challenges. The scientific literature recognises technology as one of the main strategic resources in any enterprise, and technological strategy of an enterprise is considered to be a functional strategy, determining the position of the enterprise in respect with technological changes. The importance of technologies as the tool of strategic business performance has been stressed by many scientists (Bone and Saxon, 2000; Carr *et al.*, 2010; Ürü, 2011; Citroen, 2011; Vecchiato, 2012). They emphasised critical interaction between general and technological strategies in an enterprise.

Technology in the manufacturing industry refers to the tools, equipment and systems used to manufacture goods. The number of newly developed technologies that could be chosen by industries today has significantly increased. This is extremely important for manufacturing enterprises, whose successful development of the activity requires expeditious strategic decisions, constant analysis of business environment and predictions of new technological alternatives. At this decision point, new and emerging technologies compete for capital investment alongside more established or mature technologies. Economists often assume that an enterprise needing new equipment will purchase outright the most advanced technology available at the time. The frictionless acquisition of new technologies is a common modelling assumption (Hamel, 2000; Bethuyne, 2002; Hoppe, 2002; Powell & Moris, 2002). But, in fact, companies do have an alternative: they can choose to wait. In particular, when a technology is expected to improve over time and when the company's investment in technology is at least partially irreversible, the option value of waiting may be significant. An enterprise considering investment in new technology must wrestle with a difficult trade-off of whether to buy now or buy later. Companies will typically not implement until the new technology is substantially more profitable than the old technology. Enterprises will also forego investment in the old technology while it is still more profitable than the new technology. Conserning this question, *the main purpose of the research is to evaluate business environment factors of the Lithuanian industrial enterprises, conditioning the selection of time to implement new technologies.*

In scientific publications, the implementation of new technologies is interpreted as a conversion of the potential of science and technical advance, embodied in new products or processes (Mohr *et al.*, 2001; Hill, 2003; Krusinskas & Vasiliauskaite, 2005; Vasauskaite *et al.*, 2011). Implementation is a part of the process of adopting new technology, designing a system and its component of change. Implementation refers to the design team strategy and actions for seeing that a system is successful and makes a contribution to the enterprise. The implementation of new technologies should be justified on the basis of multiple objectives rather than single objectives such as maximization of return on investment, or minimization of payback. Assessment of implementation is essential for assessing the internal and external validity of interventions. Very often strategic technological implementation decisions are delayed waiting for additional information on investment justification. But market pushes management from the other side – waiting for additional information is consuming time and possible revenues that will never be recovered. In this case, technology investment risk deals with risk to invest too early and risk to invest too late. Management problem to the company becomes balancing between waiting and increasing company's value as much as it is possible or losing a part of cash flows because of delayed investment under market uncertainty. The best decision timing is achieved when the value of a decision is maximized by balancing the time need to gain the knowledge that informs the choice against the benefit loss that may result due to delay of decision implementation.

Many scientists evaluate the technology as an integrated phenomenon that combines different, interrelated and interactive technical and social factors (Branscomb, 2002; Brunner & Cali, 2006; Agmon & Messica, 2006; Vasauskaite *et al.*, 2011). In order to understand the dynamics of the decision-making process, it is important to perceive what drives technology change and how the overall business environment factors affect industrial enterprises' performance. The drivers

stipulating changes in valuation practice are as follows: the urbanization process, property market globalisation, good governance and property development process, actual global financial crisis and economic instability, sustainability and environmental management, extreme weather events, and new technologies. Considering the tendencies of the development of the competitive environment, the scientific literature (Gray & Larson, 2000; Ellis & Shpielberg, 2003; Baccarini *et al.*, 2004; Chambers, 2004; Fontes, 2008) highlights these main factors influencing the decision of the companies to implement new technologies: saturated markets; market fragmentation; mobile production; globalization of the markets and investment; rapid technological development; shorter life cycle of technologic monopolies; brand assimilation; constant search of the optimal price-quality ratio.

Analysing the cases more deeply, it can be proposed that in spite of the fact that the changes emerging due to the implementation of technologies cannot always be evaluated with proper accuracy, intention to increase company's competitiveness and additional value created can be considered to be the most important factors of new technology implementation: companies try to consider competitors' actions, behave in a way to gain an advantage over them and meet customers' needs with lowest costs. It is natural that the aspects mentioned above have a significant impact on the process of new technology implementation. The issues of investing in new technologies are neither simple nor fast-made. Uncertainty and development tendencies of new technologies are some of the main factors while making the decisions of technology implementation (Vasauskaite & Krusinskas, 2009). Uncertainty of technologies includes obscurity rising due to future market conditions (customers' reaction to new technologies, competitors' actions) as well as the internal capacity of the company (accurate investment costs in the new technology, necessary professionals to work with it) and many other factors. The significance of the assessment of technological uncertainty becomes even more striking when an enterprise has to make a strategic investment decision and at the same time – the decision of technology implementation assessing how the technology is going to change over the particular period in the future. The process of technological development is stochastic. That is why an enterprise is not usually able to change or regulate it. The companies working in the industrial sectors with fast changing technologies fully return the invested capital only in rare cases. However, choice of a new technology working in such business structure is inevitable. These strategic choices are extremely important not only due to high investment costs but also because of their impact on the activity of the company many years ahead. The company investing in a new technology not only obtains a particular equipment enabling to perform a new process, improve current or create new products and services, but also forms a competence and intellectual potential which eventually contributes to company's competitive advantage in the market.

To improve competitiveness and retain sustainability, each industrial enterprise requires new technologies and capabilities. Many acquisitions failed to achieve their objectives and resulted in poor performance because of improper technology choice or wrong timing for implementation (Stenbacka, 1994; Lee *et al*., 2000; Hoppe, 2002). The implementation of new technology models mainly implies a systematization of innovation processes to facilitate strategic decisions on questions like what should be developed inside, what should be integrated from outside, and what should be developed in cooperation with other enterprises or institutions.

Sharma (2007) analyzes the literature of adoption of innovation and extracts a number of factors which are grouped to organizational readiness factors, technology factors, external environment factors and interorganizational relationship factors. The scheme presented in Figure 1 shows the links of interorganizational relationships with the innovation adoption timing process.

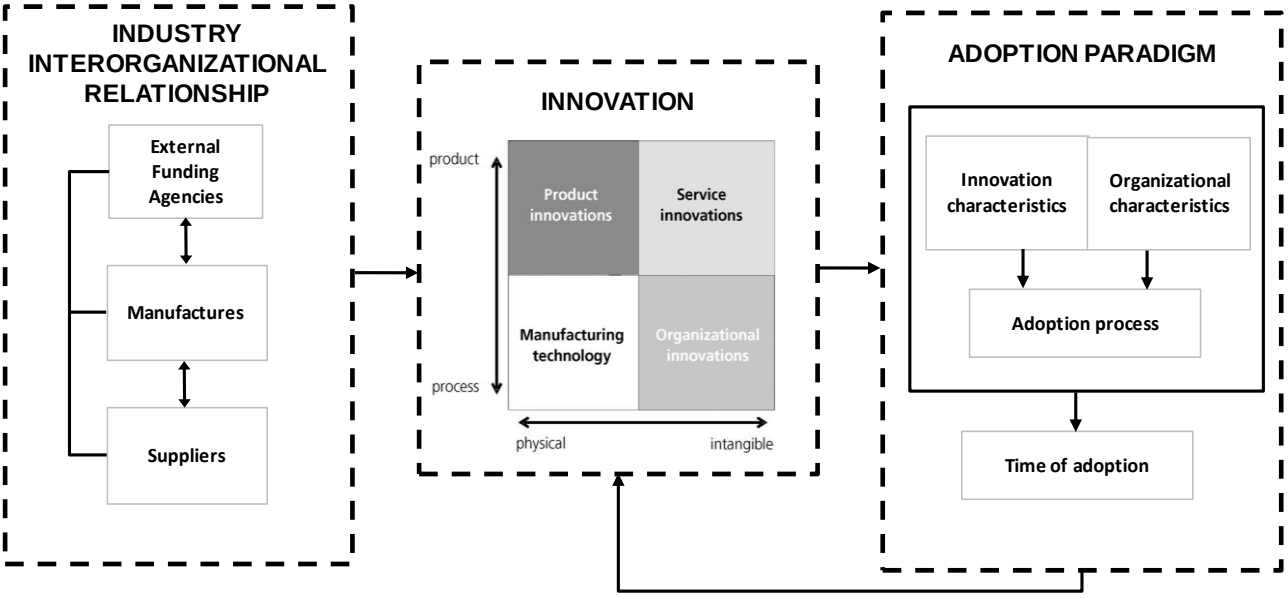

Figure 1. A framework linking interorganizational relationships with the innovation adoption paradigm

Source: adapted by the author with reference to Kirner *et al.* (2009), Fichman (2000)

The industry, where the technological innovation has been developed, is clearly linked with the adoption process. Earlier research or adoption processes failed to clearly consider structural characteristics of industries other than competition effect. Many studies presumed that there is only one innovation-providing enterprise concentrating only on a manufacturer. In fact, this condition is very rare. What is more, in the case of government-funded development projects, the structure and diffusion of technological development differs from the ones in private industries. The analysis of this model includes some aspects.

Firstly, the responsibility for the diffusion of technological innovations usually goes to independent funding agencies which do not hold any market share. Secondly, interorganizational relations are important not only for suppliers, i.e. funding agencies and technology manufacturers, but also for potential technology implementers or supply-side companies in a particular industry. Positive experience reduces perceived uncertainty in the relationship. Trust gradually builds up over time, based on accumulated positive experience. Therefore, one of the reasons for establishing long lasting relationships is to reduce uncertainty. For innovations that require the establishment of new relations with suppliers, uncertainty will likely be higher than for innovations build on the existing relations with suppliers. Thirdly, interorganizational relations, formed in a particular industry, have an impact on the type and frequency (intensity) of communication between the participants. These interorganizational relations contribute to the obtaining of valuable external information, including the one about innovations, as well as the intensification of the communication with potential implementers.

Although the scientific literature often emphasises the impact of the factors of internal and external environment on the decisions of new technology implementation (Agmon & Messica, 2006; Ketokivi & Schroeder, 2004; Lee *et al.*, 2000), it is still lacking of a comprehensive analysis to identify the main influential factors and their impact on the technological strategy formation, which would enable to increase the efficiency of the decisions of technology implementation.

2. Method

For the evaluation of the main business environmental factors determining decisions to implement new technology in Lithuanian manufacturing enterprises, the method of the expert evaluation was used. The advantage of this method, first of all, is greater accuracy and scientific

objectivity. Since the purpose of this research was to find out the opinion of the experts, the most suitable method for data collection for this purpose is questionnaire survey. In order to get the results the best reflecting the real situation, the survey was carried out participating personally. With this approach, the research includes the characteristics of a structured interview. As it was earlier mentioned, the survey was carried out directly following the questionnaire prepared beforehand, personally providing the experts with the questionnaire, mediating and inviting them for the scientific discussion. Such method of the survey was chosen as more efficient in comparison with the survey by e-mail since the probability to get the answers reflecting the real situation is higher using the method of personal participating. The research was oriented not to the questionnaire survey massification, but to the competence of the experts, their knowledge of technology implementation in industrial enterprises and the problems related with that.

Applying the qualitative method of the expert evaluation, recommendable number of the experts can range from 10 to 100 people. Competence and impartiality of the experts were considered while making the sample. 30 experts whose activity is related to the creation and development of technological innovations or implementation of new technologies in enterprises were included in the research. Qualification and practical experience of these people allows to treat them as experts in this sphere. The people representing the scientific, business and advisory institutions presented their expert evaluations. The selection of the experts for the research is not random, but directly related to the topic to be researched. The experts were personally provided with the questionnaires, they did not know the structure of the sample and do not have any contacts with each other. Therefore, it can be considered that the experts did not have any impact on each other's opinion. The data of the expert evaluation was analysed using SPSS (Statistical Package for Social Sciences) and Microsoft Excel software package. Calculations were made with reference to the statistic research methods presented by different authors (Tabachnic & Fidell, 2001; Čekanavičius & Murauskas, 2002; Boguslauskas, 2003; Bagdonas, 2009).

Cronbach alpha coefficient was calculated in order to found reliability of the results of the empirical research and the questionnaire. Considering recommendations of the scientists Malhotra and Birks (2003), the lowest chosen value of Cronbach alpha coefficient was 0.6. For the verification of the compatibility of the experts' opinions, Kendall's coefficient of concordance *W* was used. Kendall's coefficient of concordance can range in the interval $0 \leq W \leq 1$. The value of the coefficient close to 1 means that the experts' opinions are compatible. If $W \leq 0.6$, it means that the results of the expert evaluation are unreliable. Correlation between the variables was researched using Pearson correlation coefficient. Čekanavičius and Murauskas (2002) distinguish between positive and negative correlation: weak positive (negative) correlation is revealed if Pearson correlation coefficient ranges from 0.3 to 0.5 (0.3 to -0.5), and if it ranges from 0.9 to 1 (-0.9 to -1), correlation is considered to be strong positive (negative). The level of significance chosen for verification is equal to 0.05. Differences of the rates are considered statistically significant, if $p<0.05$.

3. Results

The research carried out indicated the fact that in the recent years, the connection of Lithuanian industrial progress, scientific research works, organizational changes and economic competitiveness has increased. One of many significant changes in Lithuania's technological and economic environment of industrial enterprises is related with the increasing dissemination of technological innovations and commercial profit earned having implemented new technologies in industry. According to the enterprise innovation activity survey, carried out by Statistics Lithuania in the period of 2008-2010, there were 13.7 per cent of the enterprises that introduced process innovation, and 12.7 per cent of the enterprises that introduced product innovation. Many enterprises (8.3 per cent of all enterprises) introduced both product and process innovation. In the stage of the introduction of process innovation, most enterprises purchased new equipment (70.6 per cent of all innovative enterprises) and trained their employees (62.3 per cent of the enterprises).

Research and development (R&D) activities were carried out by 55.7 per cent and R&D services were purchased by 39.8 per cent of the innovative enterprises.

The competitiveness of enterprises and the state is directly dependent on their ability to acquire and implement new business methods and new technologies, as well as use them in the production of new competitive products (Saboniene, 2010). In the process of introducing new technologies, developing new products, improving and providing them for the market, enhancing the competitiveness of enterprises and organisations, the state innovation promotion system is of major importance. The Government of the Republic of Lithuania alongside with the governments of other EU countries are looking for the ways to make the conditions favourable for innovation activities and consider the opportunities for companies to use the services of science and technology parks, business incubators and public business advisory institutions. In the period of 2008–2010, 36.6 per cent of innovative enterprises introducing technological innovation received financial support for innovation from various institutions (both Lithuanian and foreign). 6.1 per cent of innovative enterprises received support for innovation from the State budget, 34.9 per cent – from EU assistance programmes.

Evaluating the main business environmental factors determining the decisions to implement new technologies in Lithuanian manufacturing enterprises, the main and commonly used factors were selected for the research. Table 1 presents the factors determining market conditions and external business environment. These factors enable evaluation of the real external environment of the company, its position in the market, competition intensity and other important aspects necessary for companies for substantiation of their technological decisions.

Table 1. Business environment factors and indicators determining the selection of time for the implementation of new technologies

Business environment factor	Indicators of factors	Unit of measure
Level of market concentration	Number of competitors in the market	number
	Market share occupied	%
Change of consumer needs	Purchasing power of consumers	%
	Level of consumer satisfaction with the product	%
Product price in sales market	Average price of the product in sales market	thousand Lt
Market stability	Number change of enterprises in the market per year	%
Strategic decisions of other firms to implement new technologies	Number of enterprises that have implemented the new technology	number
Stability of legal and administrative environment	Complexity level of standards and norm package	%
Development level of innovation system	Level of favourable politics of the state for innovative actions	%
System of information dissemination	Means for advertising	thousand Lt
	Sales increase after the promotion	%

1. **Concentration level of market.** The bigger is the level of competition in the market and the more actively enterprises perform innovative activities, the faster is the change of the processes of implementing technologies in an enterprise. Enterprises that have not implemented new technologies in time may lose their competitive advantage. Indicators: number of competitors in the market – the number of company's competitors in the market – has been estimated with reference to the statistical data of the year researched; market share occupied is the indicator that shows the percentage ratio between the company sales and total sales in the market. It is estimated with reference to the statistical data of the year researched.
2. **Price level in the market.** Instability in the market can condition the possibility of multiple product prices. As a result, it is possible for there to be "rational" price rises or price falls in

which the gains or losses sustained by some enterprises are such as to make these price changes self-fulfilling in equilibrium. Adoption pattern is characterized by pre-emption and increasing dominance, i.e. all new technology adoptions are performed by the same companies if there is particular price competition in the product market. Indicator: average price of the product in sales market is the indicator evaluating the average annual price of the product in the market.

3. **Stability in the market.** An unstable economic climate and up-and-coming technology continually stirs up market turbulence. The environment also plays a role in provoking market turbulence. The impact of economical or political instability results the bankrupts and performance of enterprises. Indicator: number change of enterprises in the market per year – it is the percentage change of the number of enterprises during the year, estimated with reference to the statistical data of the year researched.
4. **Increased consumer needs and demands.** Consumer satisfaction with a product is one of the most important goals of an enterprise. An enterprise has a favourable situation for implementation of new technologies if consumers are receptive to innovations and are ready to acquire them. Indicators: purchasing power of consumers – it is the percentage change of consumer price index during the year; level of consumer satisfaction with the product – it is the indicator showing the level of consumer satisfaction with the company's products made using current technology. This indicator is estimated subjectively, with reference to the data of customer survey, responses.
5. **Strategic decisions of competitors.** An enterprise's incentive to adopt a new technology at a certain point in time may therefore crucially depend on the rival companies' adoption decisions. Implementation of new technologies by other competitive enterprises forces an enterprise to perform strategic actions and to implement corresponding or more innovative technologies seeking to keep their competitive advantage or their market share. In particular, a potential advantage from being first may introduce an incentive for pre-empting rival companies, thus speeding up the first adoption of a new technology. On the other hand, quality-improving technological progress may give rise to a late-mover advantage, which may slow down adoption. Indicator: number of enterprises that have implemented the new technology – it is the number of the enterprises that have implemented the new technology appealing to the particular company; the indicator is estimated with reference to the statistical data of the year researched.
6. **Political climate, favourable for innovations.** Actions of implementing technologies in enterprises may be stimulated by the state means for promoting innovative activities (e.g., a set easy VAT, covering of a certain part of costs, a lower profit tax, etc.). Indicator: complexity level of standards and norm package – it is the indicator evaluating the level of necessary documentation and bureaucracy that the company will need to pass in order to acquire and implement the new technology; the indicator is estimated subjectively.
7. **Development level of innovation system.** Technology development is a result of complex set of relationships among participants of the system, which includes enterprises, universities, government and research institutes. High levels of technical collaboration, technology diffusion and personnel mobility contribute to the improved innovative capacity of enterprises in terms of products, patents and productivity. Indicator: level of favourable politics of the state for innovative actions – it is the indicator subjectively evaluating the effort of the state to promote innovation activities and technological development in companies).
8. **Information dissemination system.** Information dissemination is important in the operation of every market, including, recently emerged, on-line markets for products and services. Market participants utilize available and relevant information to decide upon their actions and improve their welfare by trading and consuming resources. An important component of all information that market participants utilize, is information that pertains directly to the products and services that are traded. Indicators: means for advertising – it is the amount of money for advertising the company and its products; sales increase after the promotion – it is the indicator evaluating how

company's sales increased after product promotion; the indicator is estimated subjectively by company's managers with reference to company's reports and statements.

Table 2. Numerical characteristics of the expert evaluation on the business environment factors determining the selection of time for the implementation of new technologies

No	Factors that describe market conditions and external business environment	Numerical characteristic										
		Average	Mediana	Moda	Minimum value	Maximum value	Average squared deviation	Asymmetric coefficient	Coefficient of variation	Kendall's coefficient of concordance	p-value	Weight coefficient
1.	Level of market concentration	3,97	4	5	2	5	1,098	-0,6	0,28	0,46	0,000 (<0,05)	0,145
2.	Change of consumer needs	4,20	4	4	3	5	0,610	-0,117	0,15			0,154
3.	Product price in sales market	4,10	4	4	3	5	0,712	-0,147	0,17			0,150
4.	Market stability	3,57	3,5	3	1	5	0,858	-0,396	0,24			0,130
5.	Strategic decisions of other firms to implement new technologies	3,50	4	4	2	5	1,106	-0,164	0,32			0,128
6.	Stability of legal and administrative environment	2,83	3	3	1	5	0,986	-0,107	0,35			0,104
7.	Development level of innovation system	2,80	3	2	1	5	0,961	0,6787				0,102
8.	System of information dissemination	2,37	2	2	1	4	0,890	0,4329	0,38			0,087

The results of the evaluation of the significance of different factor groups propose that in the group of the factors determining market conditions and business environment, the factors having the biggest impact on company's strategic decisions to implement new technologies are level of market concentration (0.145), change of consumer needs (0.154) and product price in sales market (0.15).

4. Discussion

The theoretical studies point out the number of the factors that influence enterprise's decision to implement a new technology at a certain point in time: under uncertainty, individual information acquisition, learning from the adoption experience of others, interorganizational relationship as well as under strategic interaction in the product market and the nature of adoption, timing can be one of either pre-emption or waiting.

The results of the expert evaluation show that the most important external business environment factors determining the selection of time for the implementation of new technologies in manufacturing enterprises are as follows: the level of market concentration (0.145), the change of consumer needs (0.154), and product price in sales market (0.15).

Generally speaking about the technological performance and perspectives of Lithuanian industrial companies, it should be noted that poor Lithuanian natural resources stimulate mobilization of other kinds of promising resources under the modern conditions. The most important of such resources are skilled work force and entrepreneurial potential with the ability to uptake new technologies rapidly and accelerate technological progress. Lithuania has the necessary potential for rapid technological progress: the potential of applied sciences and opportunities to systematize the knowledge of different spheres, production of high technologies (laser and biotechnologies), provision of knowledge-intensive services, industrial use of many fundamental technologies, sufficient concentration of industry and science in the country. On the other hand, Lithuania has few opportunities to become a creator and an exporter of new technologies. Lithuanian industrial companies see it worthwhile to acquire new technologies from abroad due to the following reasons: comparatively lower prices, high service quality and methods of payment. From the other side, the development of the activities of technological innovation oriented only to

foreign equipment is dangerous with respect to technological lag. For example, orientation to current markets of information technologies, "retreating industries" has been negatively evaluated by the experts. According to them, it is necessary to consider not current but future markets, the markets of a new technological product. In Lithuanian, this problem is extremely important since significant technological lag can cause the situation when the technology of new generation will be too complicated for the professionals to understand and use it efficiently, especially in the industries of high technologies, where the concept and evaluation of technology is fast changing.

The research was funded by Research Council of Lithuania according the project "Postdoctoral Fellowship Implementation in Lithuania".

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