DOI: 10.20472/BM.2015.3.4.003

THE IDENTIFICATION OF DIFFICULTIES IN USING ADVANCED TECHNOLOGIES IN THE IMPLEMENTATION OF PROJECTS

REMIGIUSZ KOZLOWSKI, MAREK MATEJUN

Abstract:

The purpose of the article is to identify difficulties in using advanced technologies in the implementation of projects and their causes, taking the size of enterprises into account. Analysis of the difficulties in using advanced technologies, which occurred during implementation of projects, and of their causes, was carried out, based on a research questionnaire which was administered online and in which 787 business entities participated. The size of enterprises was taken into account in the research study. Using advanced technologies causes a number of difficulties in business practice. Findings of the research study identify types of these difficulties and give their causes. The conclusions that were drawn from the study enable attention to be drawn special to the most problematic areas of business activities connected with implementing projects with the use of advanced technologies. This research paper offers a new classification of advanced technologies as well as of their causes. The paper identifies and classifies not only the technologies, the types of enterprises (according to their size), but also the most frequent causes of the difficulties which occur during implementation of projects. This allows us to focus on the areas of activities which are most prone to difficulty occurrence.

Keywords:

Advanced technologies, difficulties of using advanced technologies, project management.

JEL Classification: L25, O32, O32

Authors:

REMIGIUSZ KOZLOWSKI, Faculty of Management, University of Lodz, Poland, Email: remigiuszk@poczta.fm
MAREK MATEJUN, Faculty of Organization and Management, Lodz University of Technology, Poland, Email: matejun@p.lodz.pl

Citation:

REMIGIUSZ KOZLOWSKI, MAREK MATEJUN (2015). The identification of difficulties in using advanced technologies in the implementation of projects. International Journal of Business and Management, Vol. III(4), pp. 41-60., 10.20472/BM.2015.3.4.003

Introduction

Project implementation is a challenging task which is always burdened with risk (Costin, 2008; Kerzner, 2013; Webster, 1999). There are numerous factors which determine whether projects will be successful or not (Belout and Gauvreau, 2004; Camilleri, 2011; Shahu *et al.*, 2012). To increase the task's chance for success, almost all projects are currently implemented with the use of advanced technologies.

Apart from positive effects of using advanced technologies in business practice (Waldeck, 2000; Pantado and Timmermans, 2011; Coad, 2009), some difficulties connected with using such technologies, may occur (Brown, 1998; Li and Poser, 2008; Farrugia, 2005). The examples of such difficulties, reported by enterprises of different size, inspired the authors of this research paper to identify the scale of this phenomenon and to determine the types of difficulties arising from the use of advanced technologies for the implementation of projects. Therefore, the main purpose of this paper is to identify the difficulties connected with using advanced technologies in the implementation of projects and their causes, taking the size of enterprises into account. This led to the formulation of the following hypotheses:

H1. Large-sized enterprises use computer software more often than enterprises of smaller size to assist their project management.

H2. The number of difficulties increases along with the level of complexity of a given technology.

H3. The smaller the enterprise the bigger the difficulties connected with people dealing with advanced technologies.

H4. The difficulties to integrate the new The difficulties to integrate the new technologies are more significant in larger enterprises.

The empirical research, which was carried out, allowed not only to determine the scale of the difficulties connected with advanced technologies and the types of these difficulties, but it also allowed the identification of the causes of these difficulties.

Advanced technologies and the risks connected with their use

Definitions of advanced technologies have been changing over the past decades (Segal, 1994, Varga, 1998; Naisbitt *et al.*, 2001). Many authors give different definitions of advanced technologies which include groups of parameters which define them e.g. (Groen *et al.*, 2008; Liu *et al.,* 2009; Mohr *et al.*, 2010):

- government – based classifications,
- classifications based on shared industry characteristics,
- various types of innovations.

Advanced technologies are also frequently used in the implementation of projects (Badiru, 1996; Archibald, 2003; Milosevic *et al.,* 2010). They are used both as main technologies (Cantwell *et al*., 2004; Turpin and Krishna, 2007; Draheim, 2010) and as assistive technologies (Schwanke and Smith, 2005; Wendt *et al.,* 2011; Oakey *et al.,* 2013). The use of advanced technologies seriously influences working conditions

(Kortelainen, 2008) and the expectations for the workers (Lewis and Zhenhua 2005; Ming - Tien *et al.,* 2010; Williams, 2002). Numerous advantages of implementing advanced technologies have been widely researched and described in scientific literature (Majumdar *et al.*, 2010; Perlstein, 2011; Michaelides *et al.*, 2013).

However, the difficulties that may occur while implementing projects with the use of advanced technologies are much less recognized. There are many of such difficulties. This research paper will focus only on the chosen types of difficulties, while the other, such as the area of patents of the new technologies, will be omitted (Cao and Zhao, 2013).

The right choice of advanced technologies is of a crucial importance (Peng and Jang, 2013; Shengbin and Bo, 2011; Jigeesh, 2012). For example, some of the difficulties with the right use of advanced technologies arise, for example from short-term planning possibilities (Cooper *et al.,* 1992; Sood and Tellis 2005; Gnibba-Yukawa and Decker, 2012) which are caused by the dynamic and unpredictable changes in the sector of advanced technologies, such as the software industry (Hakala, 2013) and the fast-changing expectations of the clients (Nathan *et al.,* 2005).

While choosing the right new technology, the level of knowledge and the skills of people who will use these technologies have to be taken into consideration (Firestone, 2003; Aasheim *et al.,* 2009; Ming-Tien *et al.,* 2010). This knowledge is embedded in the minds of professional and technical staff (Martinkenaite, 2012). The workers, usually become more skilled in order to work with high technologies (Faustino and Vali, 2013).

Another source of difficulties in using advanced technologies can be the level of their complexity (Antonelli, 2011; Ford *et al.,* 2012; Marler and Liang, 2012). Also in this case, the attention should be drawn to the possible occurrence of complications.

The research study also emphasizes the importance of integrating the newly implemented technologies with the already existing technologies (Corchuelo *et al.,* 2003; Zurawski, 2007; Karlsson *et al.,* 2010). Without a doubt, new technologies which are not well suited may cause many problems in the functioning of an enterprise.

The quality of the implemented new technologies is also of a great importance (Zairi, 1993; Wessner, 1999; Schulz, 2012). Poor quality of the technology may generate a number of difficulties, and in some cases, it may even lead to the necessity of withdrawing the new technology and purchasing a new one.

Enterprises may also meet difficulties with access to technology specialists who would be able to use the newly implemented technologies (Kinnie and Arthus, 1996; Viardot, 2004; Or *et al.,* 2005). To avoid such problems, enterprises should research the job market for such specialists and in case they are not available, send a group of their own employees to special training courses.

Another important aspect of the new technologies is their reliability. This aspect is well known and widely discussed in the literature (Bennett and Zhao, 2004; Pascoe, 2011; Cenfetelli and Schwarz, 2011).

Study characteristics

To verify the formulated hypotheses and to fulfill the main purpose of this paper, an empirical study was carried out on a sample of 787 business entities operating their business and implementing their projects in the EU. The study was based on an electronic questionnaire (Reynolds, Woods and Baker, 2006). To ensure that the study was safe and reliable enough, a comprehensive questionnaire was featured on the Internet. The respondents had to log-in to participate in it.

The sampling was planned, and the main criteria that was taken into account, was the information whether the observable entities had participated in any substantial project in the past three years (substantial from the point of view of the entity's business activity). The study attempted to sample entities from different size categories so that different sectors of the economy were represented. In the result, four groups of observable entities were identified for the purpose of data analysis: micro enterprises (17%), small-sized enterprises (33%), medium-sized enterprises (29%) and large-sized enterprise (21%). The definition of SMSs was adopted from the EU recommendation (2003).

The projects, which were analyzed in the study, were implemented by entities which operated their businesses in different fields of the economy. For the purpose of the study, these fields of operation were categorized into the following sectors: manufacture, construction sector, services, trade, education. In cases when one entity operated in more than one of the listed sectors e.g. manufacturing and trading company, such entities were put into both categories The study showed that the services were the most common sector (38%), the second most common sector was the manufacture sector (29%) and the third was the trade sector (25%). The least of the entities featured in the study came from the construction sector (5%) and the education sector (3%).

All the entities ran their businesses in the European Union. The study featured enterprises from Austria, Bulgaria, Cyprus, the Czech Republic, Germany, Ireland, Italy, Netherlands, Poland, Spain, and the United Kingdom. All of the enterprises which took part in the study implemented some kind of projects during their business activity. The questionnaire, required from the entities to base their answers on a chosen project which had a substantial (strategic) meaning for the enterprise's business and which could be treated as a point of reference about the main rules of the project management strategy adopted in that enterprise.

The respondents of the questionnaire were the representatives of the examined enterprises, who were involved in the project implementation process. These were the members (91%) or the managers (9%) of project teams. All of them participated in at least one stage of implementation of the analyzed projects. 48% of the respondents participated in the project planning process, and 16% were involved in the evaluation and control stage, while 68% took part in the implementation process. Furthermore, 17% of the respondents participated in the whole project life cycle.

Results of the research

Characteristics of the technologies used in the implementation the analyzed projects

For the purpose of the study, the following categories of advanced technologies were adopted:

- technologically advanced machines and devices,
- technologically advanced materials,
- technologically advanced services,
- computer software.

Very frequently, more than one of the technologies from the above-listed categories was used for the implementation of the analyzed projects. Computer software was used in 64% of the cases. Software was used not only at the initial planning stage but also at the stages of implementation, analysis, evaluation and archiving of the knowledge collected during the implementation of the project.

In 45% of the analyzed cases, technologically advanced machines and devices were used. The respondents listed the following types of technologies:

- automated machines used for manufacturing and for providing services,
- quality control and measurement devices,
- industrial robots,
- devices for data sending, collecting and analyzing,
- devices providing security for the projects and for the employees (e.g. alarm and rescue systems),
- laboratory equipment,
- tools and devices used for tasks which require precision e.g. in medicine, in jewelry trade, in antiques renovation etc.

The study shows that in 22% of the analyzed projects, technologically advanced materials were used. The respondents listed materials such as:

- technologically advanced materials used in medicine, manufacturing and engineering (e.g. fast setting concrete),
- chemicals used for antiques reconstruction.

Technologically advanced services were used in 21% of the analyzed projects. The following services were listed:

- data analysis services using the Internet applications,
- Information and Communications Technology (ICT) services allowing for work in a distributed environment (all the employees work in different locations) and for mobile work (portable workstations allow the workers to move around without interrupting their work),
- services providing teleconferences and videoconferences,
- telehosting services and other services providing charged access to specialized software via the Internet.

Table 1 shows the use of a given type of advanced technology taking the size of an enterprise into account.

Table 1.
The use, expressed in %, of a given type of advanced technology in the implementation of projects.

	technology type			
size of an enterprise	**machines and devices**	**materials**	**services**	**software**
micro	50	22	20	64
small	43	23	26	61
medium	34	14	13	48
large	58	29	26	91

Sources: Own elaboration based on survey results

The table above clearly shows that large enterprises used software to assist their project management. This in turn, supports the H1 hypothesis. The remaining types of advanced technologies were used for purposes required by the character of the analyzed project.

The scale and the structure of the difficulties of using the advanced technologies

The use of advanced technologies influenced some of the projects' parameters such as: quality, incurred costs and lead time (Lock, 2007; Schwalbe, 2010; Marks, 2012). The results of the study show that in some cases these parameters were not kept on a satisfactory level after implementing advanced technologies. For instance:

- in 11% of the cases the lead time was extended,
- in 18 % of the analyzed projects the incurred costs increased,
- in 2% the analyzed projects the use of advanced technologies resulted in poorer quality.

A conclusion can be drawn from the above mentioned results, that advanced technologies can have both positive and negative influence on the implementation of projects.

As the research data shows, different kinds of advanced technologies generated different types of difficulties and their character was varied. The biggest percentage of difficulties (42%) was caused by computer software, 30% was generated by technologically advanced machines and devices. In 14 % of the cases, difficulties resulted from the use of technologically advanced services and materials.

However, when the number of uses of a given type of advanced technology is taken into account, then the frequency of problem occurrence is the following:

1) technologically advanced materials – 11%,
2) computer software – 22%,
3) technologically advanced services – 27%,
4) technologically advanced machines and devices – 41%.

Data presented above clearly supports the H2 hypothesis. Technologically advanced materials are the least advanced technology out of the presented ones, and the technologically advanced services (which make use of e.g. computer software) are the most advanced technologies.

Table 2. presents numbers, expressed in %, of how often difficulties with using advanced technologies occurred, taking the size of an enterprise into account.

Table 2.

Occurrence of the difficulties, expressed in %, with using advanced technologies, taking the size of an enterprise into account

	technology type			
size of an enterprise	**machines and devices**	**materials**	**services**	**software**
micro	28	10	19	21
small	54	11	28	22
medium	35	9	34	19
large	41	13	23	24

Sources: Own elaboration based on survey results

No final conclusions can be drawn from the data presented above, as the distribution of difficulties' occurrence does not show any clear scheme.

The character of the difficulty resulting from the application of advanced technology in project implementation is of big importance: All the difficulties reported by the respondents were categorized according to their character in the following way:

- **Technology selection** – difficulties in evaluating whether a given advanced technology is well suited for the needs of the project. This type of difficulty may occur when the market offers other advanced technologies which might have better potential for implementing a given project.
- **Level of knowledge and skills of the project team members** –this category deals with difficulties connected with an unsatisfactory level of knowledge and skills of the employees and with the possible need for sending the employees to special training courses.
- **Complexity of a given technology** – this category deals with difficulties connected with the facts that the new technologies often cause more work and generate problems with their use.
- **Integration of the new technologies with the already existing ones** – this category deals with possible difficulties connected with integrating the new and the existing technologies.

- **Quality of advanced technologies** – this category deals with difficulties connected with poor quality of the technologies discovered after their set-up and the first-time use.
- **Access to technology specialists** (implementation specialist, instructors, service engineer), who implement new technologies – this category deals with evaluating if those specialists were employed to participate in the project implementation. In case they were not, with answering the question whether such specialists are available on the job market, and if there is a professional service available in the area in which a given project is implemented.
- **Level of development of the new technology** – this category deals with difficulties resulting from the fact that hidden defects were discovered, and they had to be removed by the technology provider.
- **Reliability of the technology** – this category deals with difficulties connected with breakdowns occurring during starting and using the new technology.

The research data on types of difficulties, which occurred during project implementation, was analyzed separately for each type of the advanced technology.

In case of technologically advanced services used in the implementation of projects, most difficulties (23%) were observed with regard to access to specialists, who would be able to provide those services in a proper way. A big part of the difficulties were also connected with the quality of those services (20%). In 20% of the cases there were also difficulties with the integration of the new advanced technologies with the already used technologies e.g. ICT services did not ensure proper functioning of information systems.

The respondents also reported about difficulties with selection of a proper advanced technology (16%). In such cases, the respondents, at the moment of selecting advanced technology, knew about other advanced technologies on the market. It often turned out that those technologies that they did not choose, were better suited for their project. Such improper selection of advanced technology resulted in:

- overload of devices such as servers, machines, etc.,
- increase of costs – other technologies were cheaper,
- difficulties with using those wrongly selected technologies e.g. problems with controlling the devices, machines, etc.

In 7 % of the analyzed cases, the level of knowledge and skills of the project team members was not satisfactory enough, for them to use the technologically advanced services which had been purchased. The same amount of difficulties occurred due to defects and breakdowns of the devices. The respondents, only in 2% of the cases reported problems connected with an excessive complexity of the analyzed services.

Table 3. shows difficulties with technologically advanced services, taking the size of an enterprise into account.

Table 3.
Difficulties with technologically advanced services, expressed in %, taking the size of an enterprise into account

size of an enterprise	technology selection	complexity	break-downs	defects	specialists	quality	knowledge	integration
micro	11	0	0	4	4	0	0	0
small	3	1	1	1	7	7	1	4
medium	0	0	3	3	14	3	3	7
large	5	0	0	0	0	7	2	9

Sources: Own elaboration based on survey results

After analyzing the data on difficulties with technologically advanced services, the following conclusions can be drawn:

- micro enterprises had the most difficulties with selecting proper technologies,
- small and medium-sized enterprises – had the most problems with access to specialists, integration of technologies, with the quality of the services and with breakdowns,
- in large-sized enterprises, the biggest problems were with the quality of the services, integration of the new and the already existing technologies and with the excessive complexity of the purchased technologies.

Undoubtedly, most of the difficulties with using technologically advanced materials stemmed from the fact that most of those materials were no properly selected during the designing stage (69% of all the difficulties). The design assumed use of materials which:

- were not easily available on the market,
- were too expensive,
- were difficult to produce e.g. through chemical process on the enterprise's own account,
- required a long period of time to be produced.

In 26% of the cases, the respondents reported that the difficulties concerning technologically advanced materials were connected with their quality. In 5% of the cases the difficulties stemmed from the fact that the workers, who used them, had not enough knowledge about their proper use.

Table 4. shows difficulties with technologically advanced materials taking the size of an enterprise into account.

Table 4.
Difficulties with technologically advanced materials, expressed in %, taking the size of an enterprise into account

size of an enterprise	technology selection	complexity	break-downs	defects	specialists	quality	knowledge	integration
micro	3	0	0	0	0	7	0	0
small	8	0	0	0	0	2	2	0
medium	9	0	0	0	0	0	0	0
large	8	0	0	0	0	4	0	0

Sources: Own elaboration based on survey results

After analyzing the data on difficulties with technologically advanced materials, the following conclusions can be made:

- it is quite clear that in enterprises of all sizes, the most frequently occurring difficulty with technologically advanced materials was their quality,
- micro enterprises had problems with quality of materials more often than the bigger enterprises. This may partly be due to the fact that material providers treated such small clients less seriously and they sold them materials of worse quality or it may be also because micro enterprises purchased cheaper materials,
- large-sized enterprises had difficulties with the proper selection of technologically advanced materials and with their quality. This might be because of the fact that the materials were purchased from the cheapest providers from geographically distant countries.

In the case of computer software, most of the difficulties (39%) were connected with their integration with other software used for the implementation of the project or with other devices. The respondents reported the following difficulties with software integration:

- problems with software installation in some workstations and servers,
- problems with data migration between computer systems,
- incompatibility of the telecommunications links,
- many parameters of the existing software and devices had to be changed,
- functions of some of the controlled devices e.g. belt conveyors, manufacturing machines, etc., had to be adjusted,
- new, compatible devices had to be purchased,
- many applications had to be used simultaneously during the integration process, which increased the amount of work, its costs, and its duration.

Another serious obstacle with advanced computer software (22%) was connected with the insufficient level of knowledge and skills of the project team members. In many cases even special training courses did not solve this problem, mainly in case of older workers. The respondents listed the following problems:

- working methods had to be changed because of the use of the new software, which in turn required change of habits,

- the actual level of knowledge about the new software and the level of skills in using it among the project team members, was in fact, lower than the declared one,
- the training courses organized before starting work with the new software were too short.

In 11% of the cases, it turned out that the newly installed software had defects, which manifested themselves in the following ways:

- the system worked too slowly,
- not enough workers could use the application simultaneously,
- some functions of the software were damaged and therefore unavailable,
- information distortion occurred.

In 5% of the cases, the respondents stated that the level of software's complexity was over-excessive, which made the users' interface too complicated. The software contained options which were unnecessary for the implementation of a given project. The complexity of the software required more computer training courses. It also made some tasks more time-consuming. The respondents also observed that because of many options and functions of the data input and data reading, much more errors occurred. Frequently, the software generated reports that were too detailed and complicated. It was difficult to find the necessary information in such reports.

In 14% of the cases, the computer software was improperly selected. In such situations the following problems occurred:

- some of the required tasks could not be completed,
- mistakes were frequently made because of the constant need to look for supplementary solutions,
- language versions of the software were not suited to the users' abilities,
- low precision of defining certain parameters connected with the functioning of the software,
- system overload – the purchased version of the software was too basic,
- inability to use the already existing workstations, which had crucial meaning for the implementation of the analyzed project.

In 3% of the cases, the respondents suffered from system's frequent breakdowns, which were mainly system's „hangs". It also happened that there were no software service and maintenance specialists available (5%). In 1% of the cases, the quality of the software was not as high as expected.

Table 5 shows difficulties with technologically advanced computer software taking the size of an enterprise into account.

Table 5.
Difficulties with technologically advanced computer software, expressed in %, taking the size of an enterprise into account

size of an enterprise	technology selection	complexity	breakdowns	defects	specialists	quality	knowledge	integration
micro	1	0	0	2	1	0	7	9
small	4	1	0	3	3	0	6	6
medium	4	4	2	1	0	0	6	3
large	0	1	2	4	0	1	3	14

Sources: Own elaboration based on survey results

After analyzing the data on difficulties with technologically advanced computer software, the following conclusions can be made:

- micro, small and large-sized enterprises had the biggest problems with the integration of the new software with the already existing ones; in case of micro and small-sized enterprises this may have been caused by inability of workers to make the new and the old software compatible, and in case of large-sized enterprises it may have been because many different types of software were used at the same time,
- the medium-sized enterprises purchased computer software which was too complicated for their needs and because of that, they faced difficulties with software integration, insufficient employee knowledge, the excessive complexity of the software, and with the selection of a proper technology.

In 34% of all the cases, the most frequent difficulties were connected with integration of technologically advanced computer software with other technologies used in the implementation of the project. These difficulties were:

- problems with the assembly and the set-up of the software,
- problems with integrating the software with other necessary devices,
- difficulties with fitting the new software into the existing system so that there is room for all the devices,
- problems with connecting device's mechanism with the other devices' mechanisms,
- problems with cooperation of the device's software with other programs used for the implementation of the project,
- lowering the work productivity,
- problems with cooperation of the new software with the central operating system.

In 24% of the analyzed cases, many difficulties with technologically advanced devices resulted from inadequate level of knowledge and skills among project team members. Technologically advanced devices equipped with control software turned out to be the source of many problems.

The difficulties with operating the devices and their software caused the following complications:

- duration of many activities and even the whole project was extended,

- losses were incurred due to the fact that the manufactured products were not of full value or the provided services were of lower quality than expected by clients,
- software or the devices were damaged because of their improper use.

These problems caused that the following actions had to be taken:

- sending the workers to additional computer training courses,
- hiring technology specialists,
- persuading the workers that learning how to operate new complicated devices is worth their effort.

In 14% of the cases, the occurring difficulties were caused by improper selection of advanced technologies. This situation may stem from the fact that the process of technology selection was not properly conducted and that there was no technology manager in charge. It often happened that the technology sales representatives used their selling skills to persuade the respondents into buying more expensive technologies. It definitely increased seller's income, but unfortunately, it made the project implementation more complicated, and it incurred more costs. It also happened that people responsible for technology selection were bribed by sales representatives. Such situations definitely resulted in wrong technology choices. In turn, the following negative situations happened:

- workplace safety decreased,
- duration of many activities was extended and the productivity of work decreased,
- rooms in which the new devices were assembled had to be redesigned,
- work stands had to be redesigned and new devices had to be purchased,
- using of the new devices was difficult,
- quality of work deteriorated, because setting of the proper parameters of the devices was impossible,
- some of the works had to be interrupted in certain weather conditions,
- overall costs of the project increased – the chosen devices were too expensive,
- no work could be done because of the central system's failure,
- not all required parts of the project could be performed,
- the analyzed devices were continuously overloaded,
- the analyzed devices did not meet the standards required by the European Union.

Technologically advanced devices, purchased for project implementation, didn't always meet the expected quality standards. It happened in 9% of the analyzed cases. Another group of difficulties (7%) were connected with defects of the devices, which were the following:

- some of the device's functions did not work,
- nonconformity of the operating manual with the actual product occurred,
- the device continuously generated errors,
- defects in the construction of the device were found,
- the devices did not work properly.

In 4% of the cases, the technologically advanced machines and devices broke down. Some of those breakdowns were caused by their improper use. Most frequently, those breakdowns resulted in:

- long breaks, which put the completion of the project in a scheduled time at risk,
- permanent impairment of the device's productivity and its quality – repair service team was unable to restore the device to its state before the breakdown.

4% of the respondents reported that they had difficulties with finding technology specialists, who would professionally set up and start the technologically advanced machines and devices. 4% of the enterprises chose technologies that were too complex for their project's needs. This in turn, led to number of negative consequences, such as: increasing the overall costs, extending the lead time of the analyzed projects, and problems with organization of training courses.

Table 6. shows difficulties with technologically advanced machines and devices taking the size of an enterprise into account.

Table 6.

Difficulties with technologically advanced machines and devices, expressed in %, taking the size of an enterprise into account.

size of an enterprise	technology selection	complexity	breakdowns	defects	specialists	quality	knowledge	integration
micro	4	0	1	4	3	1	9	4
small	5	3	3	3	3	8	18	12
medium	9	1	0	0	1	0	10	13
large	5	2	2	4	0	3	1	23

Sources: Own elaboration based on survey results

After analyzing the data on difficulties with technologically advanced machines and devices, it can be concluded that:

- micro enterprises and small-sized enterprises, had problems with insufficient knowledge of their employees,
- medium-sized and large-sized enterprises predominantly, had difficulties with integrating the new devices with the already existing ones, and it was clear that the bigger the enterprise was the more problems it had, in this respect.

The analysis of the difficulties with advanced technologies used for the implementation of the projects

The research study described in this paper helped to identify the causes of difficulties with advanced technologies in the analyzed group of projects. The analysis of data collected in this research will be presented below.

The most common difficulty (28% of all the difficulties) was the problem with integrating the new technologies with the already existing ones. A great number of problems (22%) were connected with the insufficient level of knowledge and skills among project team members. These difficulties were caused by:

- improper selection of project team members,
- insufficient training courses for the workers,
- improper selection of training courses for a given project or their improper conduction.

Many difficulties were also encountered while selecting proper technology for a given project (16%). The respondents admitted that they were aware that better-suited technologies were available on the market than those which had been purchased for the implementation of their projects.

Another categories of difficulties, not directly dependant on the two mentioned above, were connected with the defects in the advanced technologies (9%), their lower than expected quality (9%) and their breakdowns (5%). These three types of difficulties, especially the breakdowns, can be quite difficult to eliminate at the stage of technology selection. The remaining causes of the analyzed problems can be avoided by choosing proper technology. Although it is possible, in practice it can be very difficult.

Table 7 shows in numbers, the given type of difficulty, which occurred during the implementation of the analyzed projects.

Table 7.
The categories of difficulties, which occurred while a given type of technology was used for the implementation of the analyzed projects.

Category of difficulty	**materials**	**services**	**software**	**devices**
breakdowns		2	3	6
complexity		1	6	6
specialists		10	6	6
defects		3	12	10
quality	5	9	1	13
technology selection	13	7	15	21
knowledge	1	3	24	35
integration		9	43	49

Sources: Own elaboration based on survey results

After analyzing the data on categories of difficulties with technologically advanced technologies, the following conclusions can be formulated:

- difficulties with materials were mainly connected with their improper selection,
- difficulties with services were most frequently related to the service quality, the problems with integration and the lack of technology specialists,

- difficulties with computer software were predominantly connected with their integration with other software or devices and with insufficient knowledge of the workers,
- difficulties with machines and devices – problems with integration, workers' insufficient knowledge and improper technology selection, predominated.

The analysis of data on the link between the size of an enterprise and the frequency of difficulties with human resources clearly shows that the H3 hypothesis can be confirmed. The study revealed that the smaller the enterprise the more problems it had with human resources, which was reflected in the study results on: level of workers' knowledge and skills, access to technology specialists and technology selection. Research results are presented in Table 3. (technologically advanced services), Table 4. (technologically advanced materials), Table 5. (computer software) and Table 6. (technologically advanced machines and devices).

The analysis of data on difficulties with different types of technologies shown in Table 3. (technologically advanced services), Table 5. (computer software), Table 6. (technologically advanced machines and devices) and in the resuming Table 7, clearly shows, that the bigger the enterprise was, the more problems with integrating new technologies it had. This interdependence supports H4 hypothesis.

Limitations and future research direction

The study did not focus on the influence of other factors which do not concern the technologies in a direct way, such as: political conditions, corruption, financial dependencies, economic business, etc.

The study provided in this paper offers a possibility of finding appropriate procedures which can be used while selecting advanced technologies for project implementation, so that the risk of occurring difficulties is minimized. The authors of this paper are going to prepare such procedure and to test it in an empirical way.

Conclusions

All the hypotheses presented in this paper were supported by the research results. Therefore, while selecting the right advanced technology which is going to be used for project implementation, enterprises should:

- adjust advanced technologies to the needs of the project for which they will be used,
- make sure that the new technologies can be easily integrated with the technologies that had already been used for the project implementation, and in case these technologies are incompatible, the new technology should not be purchased,

- check if the management and project management members have sufficient knowledge and skills to operate the new advanced technologies,
- make sure that specialists and servicemen who will set up and deal with maintenance of the new technologies are easily available,
- test the quality of the new technology,
- check if other users of the technology did not report any defects or if there were no instances of technology's breakdowns.

References

Aasheim, C.L., Lixin, L., Williams, S. (2009). Knowledge and Skill Requirements for Entry-Level Information Technology Workers: A Comparison of Industry and Academia. *Journal of Information Systems Education*, 20(3): 349-356.

Antonelli, C. (2011). *Handbook on the Economic Complexity of Technological Change*, Edward Elgar Publishing, Cheltenham, UK.

Archibald, R.D. (2003). *Managing High-Technology Programs and Projects*, Third Edition, Wiley, Hoboken, NJ.

Badiru, A.B. (1996). *Project Management in Manufacturing and High Technology Operations*, Willey, New York, NY.

Belout, A., Gauvreau, C. (2004). Factors influencing project success: the impact of human resource management, *International Journal of Project Management*, Vol. 22(1): 1-11.

Bennett, D., Zhao, H. (2004). International technology transfer: perceptions and reality of quality and reliability, *Journal of Manufacturing Technology Management*, 15(5): 410-415.

Brown, E. (1998). *Technology in Context: Technology Assessment for Managers,* Routledge, London, UK.

Camilleri, E. (2011). *Project Success: Critical Factors and Behaviours*, Gower Publishing Limited, Farnham, UK.

Cantwell, J., Gambardella, A., Granstrand, O. (2004), The Economics and Management of Technological Diversification, Routledge, London, UK.

Cao, Y., Zhao, L. (2013). Analysis of patent management effects on technological innovation performance, *Baltic Journal of Management*, 8(3): 286–305.

Cenfetelli, R.T., Schwarz, A. (2011). Identifying and Testing the Inhibitors of Technology Usage Intentions, *Information Systems Research*, 22(4): 808-823.

Coad, A. (2009). *The Growth of Firms: A Survey of Theories and Empirical Evidence*, Edward Elgar Publishing, Cheltenham, UK.

Commission Recommendation 2003/361/EC (2003). Concerning the Definition of Small and Medium-Sized Enterprises, *Official Journal of the European Union* L 124.

Cooper, W.W., Sinha, K.K., Sullivan, R.S. (1992). Measuring Complexity in High-Technology Manufacturing: Indexes for Evaluation, *Interfaces*, 22(4): 38-48.

Corchuelo, R., Ruiz-Cortés, A., Wrembel R. (2003). *Technology Supporting Business Solutions*, Nova Science Publisher, Inc. New York, NY.

Costin, A. (2008). *Managing Difficult Projects*, Elesivier, Oxford, UK.

Draheim, D. (2010). *Business Process Technology: A Unified View on Business Processes, Workflows and Enterprise Applications*, Springer, Innsbruck, Austria.

Farrugia, P. (2005). *The River of History: Trans-national And Trans-disciplinary Perspectives on the Immanence of the Past*, University of Calgary Press, Calgary, Canada.

Faustino, H.C., Vali, C. (2013). The Effects of Globalization and Economic Growth on Income Inequality: Evidence for 24 OECD Countries, *Argumenta Oeconomica*, 1(30): 23.

Firestone, J.M. (2003). *Enterprise Information Portals and Knowledge Management*, Elsevier, Burlington, MA.

Ford, S.J., Mortara L., Probert, D.R. (2012). Disentangling the Complexity of Early-Stage Technology Acquisitions, *Research Technology Management*, 55(3): 40-48.

Gnibba-Yukawa, K. and Decker, R. (2012). Comments on the Model Testing by Goodwin and Meeran (2012): Comparison of the Utility-based and the Gompertz Curve Approach for High-technology Product Sales Forecasting, *Journal of Product Innovation Management*, 29(S1): 219–228.

Oakey, R., Groen, A., Cook, G., Van Der Sijde, P. (2013). *New Technology-based Firms in the New Millennium*, Volume X, Emerald Group Publishing Limited, Bingley, UK.

Hakala, H. (2013). Entrepreneurial and learning orientation: effects on growth and profitability in the software sector, *Baltic Journal of Management*, 8(1): 102 – 118.

Jigeesh, N. (2012). Selection of Project as Important Beginning for Information Technology Project Management, IUP *Journal of Operations Management*, 11(1): 42-49.

Karlsson, C., Taylor, M., Taylor, A. (2010). Integrating new technology in established organizations a mapping of integration mechanisms, *International Journal of Operations & Production Management*, 30(7): 672-699.

Kerzner H.K. (2013). *Project Management: Case Studies*, Wiley, Chichester, UK.

Kinnie, N.J., Arthurs, A.J. (1996). Personnel specialists' advanced use of information technology, *Personnel Review*, 25(3): 3-17.

Kortelainen, K. (2008). Global Supply Chains and Social Requirements: Case Studies of Labour Condition Auditing in the People's Republic of China, *Business Strategy & the Environment*, 17(7): 431–443.

Lewis, G.B., Zhenhua, H. (2005). Information Technology Workers in the Federal Service: More Than a Quiet Crisis?, *Review of Public Personnel Administration*, 25(3): 207-224.

Li, W., Poser, H. (2008). *The Ethics of Today's Science and Technology: A German-Chinese Approach*, Transaction Publishers, Piscataway, NJ.

Liu, S., Fang, Z., Shi, H., Guo, B. (2009). *Theory of Science and Technology Transfer and Applications*, Auerbach Publications, Boca Raton, FL.

Lock, D. (2007). *The Essentials of Project Management,* Gower Publishing Ltd., Aldershot, UK.

Majumdar, S.K., Carare, O., Chang, H. (2010). Broadband adoption and firm productivity: evaluating the benefits of general purpose technology, *Industrial and Corporate Change*, 19(3): 641–674.

Marks, T. (2012). Project Management: How to Deliver on Time, on Budget and on Spec, Kogan Page, London, UK.

Marler, J.H., Liang, X. (2012). Information technology change, work complexity and service jobs: a contingent perspective, *New Technology, Work & Employment*, 27(2): 133-146.

Martinkenaite, I. (2012). Antecedents of knowledge transfer in acquisitions, *Baltic Journal of Management*, 7(2): 167 – 184.

Michaelides, R., Morton, S.C., Liu, W. (2013). A framework for evaluating the benefits of collaborative technologies in engineering innovation networks, *Production Planning & Control*, 24(2/3): 246-264.

Milosevic, D.Z., Patanakul, P., Srivannaboon (2010). S., *Case Studies in Project, Program, and Organizational Project Management,* Wiley, Hoboken, NJ.

Ming-Tien T., Cheng-Chung C. and Chao-Wei C. (2010). Knowledge workers' interpersonal skills and innovation performance: An empirical study of Taiwanese high-tech industrial workers, *Social Behavior & Personality: An International Journal*, 38(1): 115-126.

Ming-Tien, T., Cheng-Chung, Ch., Chao-Wei, Ch. (2010). Knowledge workers' interpersonal skills and innovation performance: An empirical study of Taiwanese high-tech industrial workers, *Social Behavior & Personality: An International Journal*, 38(1): 115-126.

Mohr, J.J., Sengupta S., Slater S.F. (2010). *Marketing of High-technology Products and Innovations*, Prentice Hall, Upper Saddle River, NJ.

Naisbitt, J., Naisbitt N., Philips D. (2001). *High Tech High Touch: Technology and Our Accelerated Search for Meaning*, Nicholas Brealey Ltd., London, UK.

Nathan, R.P., Bardach, E., Navarro P. (2005). Cell phone roulette and consumer interactive quality, *Journal of Policy Analysis & Management*, 24(2): 435-441.

Or, Z., Wang, J., Jamison, D. (2005). Instructional Technology Specialists and Curriculum Work, *Journal of Health Economics*, 24(3): 531-560.

Pantado, E., Timmermans, H. (2011). *Advanced Technologies Management for Retailing: Frameworks and Cases,* IGI Global, Hershey, PA.

Pascoe, N. (2011). *Reliability Technology: Principles and Practice of Failure Prevention in Electronic Systems,* Wiley, Chichester, UK.

Peng, Y., Jang, H.L. (2013). Optimal technology selection considering input levels of resource, *Industrial Management & Data Systems*, 113(1): 57-76.

Perlstein, J. (2011), Amplifying social impact in a connected age: A survey of technology-related philanthropy for social benefit, *National Civic Review*, 100(3): 45-49.

Reynolds, R.A., Woods, R., Baker J.D. (2006). *Handbook of Research on Electronic Surveys and Measurements,* Idea Group, Suite, PA.

Schulz, R. (2012). *Quality of Life Technology Handbook*, Taylor & Francis Group, Boca Raton, FL.

Schwalbe, K. (2010). *Information Technology Project Management: Project Management*, Cengage, Boston, MA.

Schwanke, T.D., Smith, R.O. (2005). Assistive technology outcomes in work settings, *Work,* 24(2): 195-204.

Segal, H.P. (1994). *Future Imperfect: The Mixed Blessings of Technology in America*, University of Massachusetts Press, Massachusetts, MA.

Shahu, R., Pundir, A., Ganapathy, L. (2012). An Empirical Study on Flexibility: A Critical Success Factor of Construction Projects*, Global Journal of Flexible Systems Management,* 13(3): 123-128.

Shengbin, H., Bo, Y. (2011). The Impact of Technology Selection on Innovation Success and Organizational Performance, *I-Business*, 3(4): 366-371.

Sood, A., Tellis, G.J. (2005). Technological Evolution and Radical Innovation*, Journal of Marketing*, 69(3): 152-168.

Turpin, T., Krishna, V.V. (2007). *Science, Technology Policy and the Diffusion of Knowledge: Understanding the Dynamics of Innovation Systems in the Asia Pacific*, Edward Elgar Publishing, Cheltenham, UK.

Varga A. (1998). *University Research and Regional Innovation: A Spatial Econometric Analysis of Academic Technology Transfers (Economics of Science, Technology and Innovation)*, Kluwer Academic Publishers, Norwell, MA.

Viardot, E. (2004). *Successful Marketing Strategy for High-Tech Firms (Artech House Technology Management and Professional Developm),* Artech House, Norwood, MA.

Waldeck, N.E. (2000). *Advanced Manufacturing Technologies and Workforce Development*, Garland Publishing Inc., New York, NY.

Webster, G. (1999). *Managing Projects at Work,* Gower Publishing Limited, Aldershot, UK.

Wendt, O., Lloyd, L.L., Quist, R.W. (2011). *Assistive Technology: Principles and Applications for Communication Disorders and Special Education,* Emerald Group Publishing Limited, Bingley, UK.

Wessner, C.W. (1999). *Advanced Technology Program: Challenges and Opportunities*, National Academy Press, Washington, D.C.

Williams J. (2002). *Team Development for High-tech Project Managers,* Artech House Inc., Norwood, MA.

Zairi, M. (1993). Competitive Manufacturing: Combining Total Quality with Advanced Technology, *Long Range Planning*, 26(3): 123-132.

Zurawski, R. (2007). *Integration Technologies for Industrial Automated Systems*, Taylor & Francis Group, Boca Raton, FL.