

THE LONG-TERM EFFECTS OF TECHNOLOGY DIFFUSION

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Abstract: A corporation must constantly come up with new ideas and be able to choose the ones that will later be able to turn into money to reach its full potential. As technological innovation will become the most important element in determining a company's competitiveness in a variety of industries, it is essential to understand both the theory and the tools, methods and tactics used in this new field. Given that SMEs have the option to implement non-reimbursable funds, they can advance technologically and thus increase their productivity, resulting in a significant profit gain. This paper presents a study performed using the method of analyzing multiple case studies. Our aim was to identify the long-term impact of technological development on SMEs that choose to use non-reimbursable development funds. The method of data collection to obtain organizational information was the content analysis of public information made available to the public by the Ministry of Finance, about those companies (part of the sample) that have implemented technological development projects under the ROP 4.3 program. . The results of the analyzes of the collected data allowed to draw some conclusions regarding the economic effects produced by the technology introduced through the development projects.

Keywords: technological development; economic effects; the theory of diffusion of innovations;

1 INTRODUCTION

Companies that focus on product development and routinely make investments in emerging technologies have typically been founded on a solid foundation of market research and strategic development. These businesses are also continually on the lookout for opportunities to diversify their product offerings and enter new target markets.

The process of innovation consists of a series of operations that aim to transform one or more ideas into goods that can be sold on the market, which translates to financial gain. Pay for your ideas because it is obvious that not all of them can be developed into items that the market would embrace. As a result of this, in order for a business to ascend to the pinnacle of success, it is imperative that the business consistently generate innovative concepts and

be in a position to choose those that have the potential to eventually be converted into monetary gain.

The progression of technology plays an essential part in the functioning of contemporary civilization. Technology, as a result of the effect it exerts, is the potent instrument that supports and sustains the competitive edge that organizations enjoy.

Every industry has, over the course of human history, seen significant shifts that have resulted in the simplification of human existence, the acceleration of human progress, and the introduction of novelties that were previously thought to be impossible.

A recent estimate suggests that sixty-five percent of youngsters who start elementary school today will end up working in occupations that do not yet exist. In addition, scientists have already shown that by the year 2030, more than one third of the skill sets connected with future employment would include components that are not now regarded as "basic." Because of this, it is now an undeniable fact that the development of technology as well as its increasing digitization will have a big effect not only on the way we perform our jobs but also, and this is very important, on the way we live our lives.

2 TECHNOLOGICAL DEVELOPMENT PROJECTS. SOURCE OF COMPETITIVE ADVANTAGE

The Romanian legislative act (LAW no. 324, 2003) provides the following definition of technological development: "Consisting of systems engineering and technological engineering activities, through which the application and transfer of research results to economic agents, as well as in social terms, is carried out, with the aim of introducing and materializing new technologies, products, systems, and services, as well as the improvement of existing ones, and which

includes: a) pre-competitive research, as an activity aimed at gaining an advantage over competitors; b) technological engineering

Project management is the method that is used in businesses today to carry out the process of developing new technologies (Seymour, & Hussein, 2014). Projects devoted to technological development serve as the cornerstone for the creation of innovative procedures and goods (Rihar, et. al, 2021), both of which are essential to the expansion of any modern business's economy. When it comes to strategic growth and development directions, however, small and medium-sized enterprises (SMEs) in our nation almost never engage in technical development. The majority of the time, programs aimed at technological growth in Romania are referred to in the scientific literature as innovation and technical transfer projects. (Rânea, et. al., 2012)

In light of this, the definition of this kind of project is as follows: "A method of arranging people and managing innovation or technology transfer operations." It is a method for arranging and coordinating the work that has to be done. What sets it apart from other types of management is the fact that it is totally focused on a certain end result, and that the minute that objective is reached, the project ceases to be essential and is finished. This is what separates it from other types of management.

Projects of this type consider how to best organize available resources, be they human or material, with the end goal of doing something that has been previously outlined. In the context of this discussion, it refers to an innovation goal or the incorporation of new technology. On the other hand, when we talk about "technical development," we are referring to a specific subset of development endeavors. The factors at play include either newly acquired information, newly developed technologies, improved technological capabilities, or an already existing technology.

The following types of endeavors are examples of technological development initiatives:

- fundamental research projects;
- basic research endeavors;
- technological basis development projects (most common).

In most cases, the result of their efforts is commercial and takes the form of the development of new components or processes. They are essential to enhancing a business's profitability by growing the number of products it offers and can even have an impact on the establishment of new businesses.

While technology development projects constitute just a small portion of Romanian managers' problems, they are crucial to the long-term prosperity of the company. They have the potential to potentially affect the company's ability to remain in business in certain circumstances.

The significance of carrying out "internal" project planning is brought into focus. In accordance with the methodological criteria that have been set and the resources that are at one's disposal, the goal of this activity is to make the entire process more manageable. These plans need to be specific enough to know exactly what needs to be done, but they also need to be "simple" enough to ensure that individuals who will really put the project into action are not overwhelmed by an excessive amount of information.

The planning process needs to be easy and methodical; also, it should be an iterative process, with better plans being generated from plans that were first considered to be less effective. It is imperative that we keep in mind that, in actuality, components of the implementation plans are created by a variety of individuals, informal groups, and different teams, and that these are then incorporated into the plan and improved upon.

The goals of a company's technology development project must be in line with the

organization's mission before planning can begin. The desired course of the company's development as well as the expected outcomes of project implementation must be identified by management. These projects frequently feature the same distinctive phases that are understood by project management science. Each phase is also connected to the methods of innovation management that are employed. Technology management concepts are based on knowledge and procedures that have been tried and true over time in a variety of professions, including engineering, law, medicine, and accounting. They have a wide range of applications in novel processes, the creation of new goods, technologies, or services, as well as in other areas.

The administration of technological development projects is a collection of specialized information (technical and economic), pertaining to the activities unique to the creation of new goods and procedures encountered in technological development.

3 DESCRIPTIVE STUDY OF THE IMPACT OF TECHNOLOGY DEVELOPMENT ON COMPANIES

A distinction is made between projects targeted at the creation of new goods and projects aimed at technological progress in the specialist literature that was researched, (Cooper, 2007; Hakansson, & Waluszewski, 2003; Barkley, 2007; Semenescu et. al., 2012; Ungureanu, 2019).

A company's "conventional" new product releases try to win over new client categories or maintain current market share. They are intended for clear-cut, foreseeable systems and procedures. Projects involving technical progress involve a lot of risk. More unknowable factors and technological ambiguity are present. The likelihood of a project's success may only be determined after working on it for months or even years.

The method of our study was specifically designed to capture the whole picture of how development initiatives affect the environment over the long term.

3.1 Methodology and data updates

The production systems that were used as the basis for this study are those that have been awarded non-reimbursable money in order to further their technical development. To be more specific, the businesses that have access to the "Regional Operational Program" (ROP) priority axis 4 "Supporting the development of the regional and local business environment" key area of intervention 4.3 "Supporting the growth of micro-enterprises."

Supporting economic and social progress in a manner that is balanced across Romania's development areas is the overarching objective of the ROP (also known as the Romanian Development Strategy). This program takes both particular requirements and available resources into consideration, putting an emphasis on urban growth poles, the upgrading of infrastructure, and favorable circumstances for business. All of this is being done in order to improve the regions of Romania, particularly the less developed ones, so that they become more appealing to potential residents.

First and foremost, the availability of public information regarding the individuals who benefitted from these funds and the particular destination of the non-reimbursable monies was a primary factor in the decision to conduct an analysis of this program. Because of this, it was a lot simpler for us to get our hands on the data we needed for the study.

This study was conducted with the intention of determining the long-term effects that the progression of technology has on the SME's that were looked into.

The first objective is to determine who will benefit from the ROP. 4.3. who have participated in the creation of technological

projects; 2. an analysis of the many sorts of impacts that the influence of the new technology has on the overall operation of the organizations that were analyzed.

In order to ensure scientific validity, it was decided that in the case of the present research, the performance of the cases studied 8 years after the start of the implementation of the development projects should be dynamically followed.

To conduct this study, 50 instances initially reported were examined, and then the so-called abnormalities were deleted. To begin, it should be noted that 14% of the investigated enterprises (7 instances) look to be written off in Ministry of Finance records in 2020. Only in 9 of the remaining 43 examples (20.93% of the total) do the enterprises show growth for all studied parameters. At the same period, two firms (cases 25 and 37) had no activity in year N+8. They were also excluded from further investigation.

The anomaly displayed by Case 48 is likewise eliminated, which had 0 workers in year N, with the company's development from the standpoint of this indicator taking place in year N+6, after 3 years from the first analyses. In addition, one firm (case 30) altered its operations in the interim and was omitted from the analysis.

The sample so collected is made up of 38 different instances.

Thus, a comparison was made only between year N (the year of project implementation) and year N+8 for the main economic indicators presented in the next subsection. However, for the observation units that started implementing projects in 2013, due to the limitation of access to accounting data only until 2020, the decision was made that the analysis should be carried out for the year N+7 (for 4 cases).

The turnover of the analyzed companies, the arithmetic average has a value that amounts to 1,803,448.5 lei. This makes it

possible to classify the analyzed sample as an SME. Also, the average number of employees for 2020 was: 7.28 people with a minimum value of 0 and a maximum of 42 employees.

3.2 Analyzed indicators

This research analyzes the following indicators:

1. Revenue;
2. Profit margin;
3. Degree of debt;

4. Average number of workers;
5. Net assets.

To be able to monitor the long-term economic consequences of the technology diffusion process through development projects, as opposed to the medium-term effects discovered in the aforementioned study, this technique was sought.

The updated data utilized for the analysis are depicted in the following figure.

2009 + 8	CA	Rata Profit	Grad îndatorare	Nr. Salariați	Active nete		2010+8	CA	Rata Profit	Grad îndatorare	Nr. Salariați	Active nete
1	69,12%	6632,38%	-89,56%	10	419,49%		18	15%	2147%	-82%	2	-57%
2							19	22%	99%	155%	4	-74%
3							20	-48%	-87%	77%	4	-132%
4	-82%	161%	56%	3	-71%		21					
5							22	4096%	-93%	-36%	7	2564%
6	150%	-5%	-8%	17	267%		23	43%	144%	-17%	8	331%
7							24	147%	-37%	158%	16	-25%
8							25	fără ac	fără ac	22%	0	-2%
9	6%	-42%	-74%	3	489%		26	10%	29%	-34%	8	170%
10	26%	-9%	85%	3	-35%		27	27%	-31%	-67%	12	85%
11	216%	190%	-30%	16	7%		28	-49%	-85%	-70%	6	459%
12	26%	-87%	-76%	5	223%		29	172%	-9%	68%	8	233%
13	86%	13%	-68%	4	32%		30	1803%	-87%	23%	7	172%
14	5%	-149%	-43%	3	-24%							
15												
16	38%	528%	28%	7	-40%							
17	-29%	-76%	39%	2	-6%							
2011+8	CA	Rata Profit	Grad îndatorare	Nr. Salariați	Active nete		2012+8	CA	Rata Profit	Grad îndatorare	Nr. Salariați	Active nete
31	-56%	4568%	4%	3	-92%		44	-30%	502%	-84%	1	195%
32	214%	-53%	39%	21	163%		45	49%	249%	-81%	8	2976%
33	2352%	117%	-29%	30	21650%		46	201%	78%	-67%	10	158%
34	492%	-221%	265%	1	-295%		2013+7	CA	Rata Profit	Grad îndatorare	Nr. Salariați	Active nete
35	112%	432%	-13%	6	806%		47	-36%	-80%	-60%	3	84%
36	75%	-12%	-24%	10	41%		48	21312%	-44,93%	-10,66%	53	16708%
37	fără ac	fără ac	-57,04%	0	-93,22%		49	-70%	40%	236%	1	-84%
38	-13%	214%	1%	5	-9%		50	24%	342%	43%	3	92%
39	36%	308%	-39%	3	162%							
40	249%	1%	56%	3	11%							
41	-5%	11405%	-63%	5	47%							
42	-88%	17%	-18%	1	39%							
43	49%	-90%	-7%	12	48%							

Figure 1. The data resulting from the updates made

4 RESULTS ANALYSIS

In terms of staff count, our cases have a total of 281 employees. We remind you that the number of workers in year N was 235, increasing to 357 in year N+2.

Hence, one can detect a 21.28 percent long-term decline in the index between the years N+2 and N+8. Nonetheless, the corporations were able to keep a portion of the increased staff created by the initiatives. Specifically, in year N+8 we may speak about an increase of 19.57 percent in comparison to year N.

The following graph depicts the evolution of this indicator:

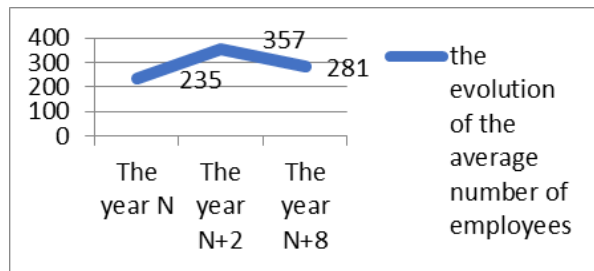


Figure 2. The evolution of the average number of employees in the studied productive systems

Considering the case-level examination of turnover dynamics, a 50.3% rise in the indicator may be noticed. The cumulative CA grew from 38,800,162 lei in year N to 58,318,354 lei in year N+8 in absolute terms. Case 22 has the greatest growth, by more than 40 times (4096%), while case 42 has the greatest fall, by -88%. These two numbers are subtracted before calculating the average increase at the group level. This totals 59%, with a mean of 26%.

This indicator has decreased in 27.77% of the remaining 36 instances for study, with a standard deviation of 112%. Table 1 presents a consolidation of statistical data regarding turnover.

Tabel 1. Variation in dynamics of turnover N+8 - statistical data

N	Valid	38
	Missing	0
	Mean	59%
	Median	26%
	Std. Deviation	112%
	Minimum	-88%
	Maximum	4096%

The profit rate is the indicator with the greatest number of instances of decline, seventeen. This indicates that 45.94% of the instances evaluated had a lower profit rate performance. At the group level, however, this metric has increased by an average of 97%.

Case 41 has the biggest gain with a 114-fold increase in the indicator (11405%), while example 34 demonstrates the largest fall with a more than twofold decrease (-221%).

For the purpose of calculating the standard deviation, the two values were deleted, resulting in a value of 1,331%, which shows a significant variance in the level of performance for this indicator within the group being evaluated. 15% is the median figure.

The statistical data summary is shown in the Table 2.

Tabel 2. Statistical data on the evolution of the profit rate in N+8 dynamics

N	Valid	38
	Missing	0
	Mean	97%
	Median	15%
	Std. Deviation	1331%
	Minimum	-221%
	Maximum	11405%

Tabel 3. Statistical data on the evolution of the debt ratio in the year N+8

N	Valid	38
	Missing	0
	Mean	-18%
	Median	-17%
	Std. Deviation	75%
	Minimum	265%
	Maximum	-89,56%

An further measure of a company's financial health is its level of debt. It demonstrates the degree to which the company's activities are dependent on the money that has been borrowed.

A debt-to-equity ratio of less than 60 percent is viewed as exceptionally positive and indicates a long-term equilibrium between internal and external sources of finance.

At the level of the complete sample of analyzed cases, the indicator saw improvements in the case of 23 enterprises (60.53%), while in 15 cases (39.47%) the degree of indebtedness grew. The average improvement at the group level in year N+8 compared to year N is 18%. In year N, the average debt level of the enterprises evaluated was 0.553059591, but in year N+8, this indicator had a value of 0.455844421.

The highest increase in the debt ratio is 265% (in instance 34), and the greatest result is an indication decline of 89.56%. (case 1).

When the two extreme values are eliminated, the standard deviation for the set of cases evaluated is 75% and the median value is -17%. The statistical indicator summary is shown in table 3.

By removing all liabilities from an organization's total assets, the net assets are obtained. This indicator represents the owners' continuing participation in assets, which may be viewed as their wealth as a result of the distribution of capital and their involvement in the enterprise's operations. This metric refers to a financial statement's net book assets or adjusted equity.

Consequently, the Net Asset of the enterprises is the last indication used to determine the long-term consequences of the technology diffusion process.

After eight years of implementing technical development projects, it climbed by sixty percent at the level of the group of firms. The average number of currency units rose from 806,520 lei in year N to 1,287,473 lei in year N+8.

It should be noted, however, that 34.21 percent of corporations (13 instances) had a decline in net assets during the time under review. This was presumably accomplished because, in 11 of the 13 cases reviewed, the company's level of debt similarly climbed.

In instance 45, the largest growth in net asset value was over 30 times (2976%), however

in case 34, the company's wealth decreased by nearly 3 times (-295%). The group under consideration has a standard deviation of 447%, with a median of 48%.

Table 4 displays a consolidation of the statistical data for the net asset.

Tabel 4. Statistical data on long-term net asset evolution

N	Valid	38
	Missing	0
	Mean	60%
	Median	48%
	Std. Deviation	447%
	Minimum	-295%
	Maximum	2976%

5 CONCLUSIONS REGARDING THE LONG-TERM EFFECTS OF TECHNOLOGY DIFFUSION

This study was conducted because there was a strong interest in looking at the long-term impacts of the process of technology diffusion through development projects carried out by the businesses that comprised the original sample.

As a result, a number of inferences may be formed concerning the development of the group that was investigated, while concurrently, a contrast can be created between the current findings and those that were acquired in the past.

A. If we look at a collection of businesses as a whole, we can draw the following conclusions:

1. When taken into consideration as one cohesive entity, it is possible to notice a marginal rise in the economic performance of the businesses that were investigated. The following values are presented by the evaluated indicators when comparing year N to year N+8:

- Turnover rose by 59%;
- Profit rate a rise of 97%;
- The degree of indebtedness decreased by -18%;
- Net assets increased by 60%.

2. Yet, when specific cases are investigated, it is impossible to separate their performances from the poor results of other organizations. In addition, the fact that seven of the original firms have been removed from the records kept by the Ministry of Finance, two other companies have terminated their operations, and one company has been reformed brings with it additional avenues for inquiry.

Why are certain businesses successful while others are unable to compete?

Taking into consideration the fact that we are discussing productive systems that were operational throughout the same economic time, what are the elements that had an impact on their development?

3. At the level of the instances that were examined, a tendency can be seen to maintain the additional workforce that was produced by the implementation of development projects, in which it was required for each firm to generate a specified number of new employees.

B. When we compare these findings to those of the earlier study, we may draw attention to the following aspects:

1. The rate of growth of the firms' total net assets over time has remained positive in 65.79% of the enterprises that were evaluated.

As a result, the indicator continues to show an increasing trend that is consistent with the boundaries that were previously recognized. This is helpful to the economy of the nation and

leads to economic growth that is maintained throughout time.

2. However, when comparing the workforce created by the project in year N+8 to the workforce generated in year N+2, there is a loss of 21.28% that can be detected.

Because there was no longer any legal requirement to keep new employees, about a third of the newly created employment were eventually eliminated as a result over the course of many years.

3. In the long run, a proportion of 60.53% of the firms that were assessed were able to improve their degree of indebtedness.

This indicates a return to the challenges that the companies encountered in the first year of the project's implementation.

4. There are still a number of elements that have impacted the results that have been reported by each individual instance over the long term, but these factors have not yet been discovered.

As a result, this opens up new avenues for research, particularly in the field of managerial aspects. We think that a mixed study strategy is the best way to have a better understanding of how specific cases develop over time.

6 FUTURE RESEARCH DIRECTIONS

At this time, it is plausible to hypothesize that a multitude of variables may be at play in the emergence of technical disparities and the economic performance of firms in the productive sector. There is a possibility that many of them have not yet been investigated, and we are just beginning to gather evidence of the significance of others.

In actuality, despite geographical variances in the elements impacting the adoption system, the fundamental models were constructed using deterministic tasks, which assume equal user behavior across all areas. Thus, the natural next step is to incorporate probability into the simulation model. The stochastic representation

should also mimic interactions between neighboring adopters when many adopter observations are available. As an example, the adoption of the same technology in the neighborhood would likely raise the likelihood of the adoption of the same (or other) technologies in nearby regions.

As demonstrated by the previous study pathways discussed, this article's methodological framework can expand into a variety of application areas. A future growth of the methodological foundation for:

1. Identifying potential links between the location of living and the primary determining factor for implementing development programs. What are the nature of these influences? What is their significance, and how do they influence the ultimate decision?

2. Identifying the reasons that contribute to a decline in economic performance following a process of technology diffusion in production systems.

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LEARNING SPACES, VOL I, Book Series eLearning and Software for Education, Page 422-428, DOI10.12753/2066-026X-19-056

*** LAW no. 324 of July 8, 2003 for the approval of Government Ordinance no. 57/ 2002 on scientific research and technological development. Published in: OFFICIAL MONITOR no. 514 of July 16, 2003