Selection and evaluation of technologies for the transfer to the industry

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ABSTRACT

The paper refers to the study of the issue of selection and evaluation of technologies for their transfer to the industry. For low-income countries such as the Republic of Moldova, where the potential for technology generation is low, it is very important to create policies for selecting and evaluating technologies that would facilitate the transfer of technologies that can be assimilated in that country, taking into account human resources and existing technological and financial potential.

This article highlights 27 methods used to select and evaluate technologies, the decision-making issues for which those methods are applied, and the strengths and weaknesses of some methods. Some challenges arise in the process, because the available methods are usually too simple or too elaborate for most managers and companies to be systematically understood and applied. To continue the research, there is a need to combine methods or develop a new method.

KEYWORDS

Innovation, technology transfer, methodology, criteria, descriptors of performance

1 INTRODUCTION

The process of selecting and evaluating technologies is an indispensable component of technology transfer and responds to the issue of identifying the most optimal technologies proposed for transfer within enterprises and industries. This statement is made by the author of this article based on his experience in technology selection and evaluation for at least 10 years.

Various methods of selecting and evaluating technologies from simple ones, such as financial methods, to the most complex ones, such as mathematical programming, have been developed and used to address this issue.

The methods are used to extract and process relevant information about a problem, because the reality is also too complex to manage in its entirety. Therefore, any method, no matter how sophisticated, will always be only a part of the reality it intends to reflect and can only produce an optimal result in its own particular framework.

A technology screening method can thus be a valuable tool for an organization to help choose technologies, especially if it can generate useful information in a timely manner and at an acceptable cost. There are various concerns to consider when selecting a method, as well as several different types, which are discussed below.

2 CHARACTERISTICS AND PRINCIPLES OF TECHNOLOGY SELECTION AND EVALUATION METHODS

After studying the literature presented in references, the following five aspects are considered the most important in a method of selection and evaluation of technologies, which propose the following characteristics and definitions:

Table 1: Characteristics and definitions of technology selection and evaluation methods

Characteristics	Definitions
Realism	*The accuracy of the representation of the real world and in the reflection of the company's decision on the situation, objectives, limitations, risks, etc.*
Capacity	*Ability to analyze different types of decision variables and deal with several factors (multiple time periods, changes in interest rates, etc.)*
Flexibility	*Applicability to different types of technologies and issues and ease of change in response to changes in the business environment*
Use	*Ease of understanding and application of the method. Clear, easy to understand by all members of the organization and executed quickly*
Cost	*The costs of setting up and using the method should be less than the potential benefits of the technology and relatively low in the cost of the technology*

Easy computerization	*Easy collection, storage and handling of information with readily available software (such as Excel®)*

In the literature there is an extensive list of "good practice" principles for technology management tools observed by several authors, some of which apply in particular to technology selection and evaluation tools, such as:
• Robust (theoretically possible and reliable)
• Economical, simple and practical to implement
• Integrated in other business processes and tools
• Flexible (adaptable to suit the particular context of the business and its environment)

There are a wide range of methods that have been used to select and evaluate technologies, from simple cost analysis to full and linear programming or more flexible methods such as fuzzy mathematical programming.

Research on the selection and evaluation of technologies dating back to 1959, where several criteria and methods of mathematical programming were already used. Reference is made to works that use the following methods: scoring, ranking, decision trees, theoretical approach to the game, Delphi technique, fuzzy logic, hierarchical analytical process (AHP), goal programming, dynamic programming, linear programming 0-1, programming quadratic and nonlinear programming. Some methods can even be used together, which further increases the number of possible techniques to be used for the selection and evaluation of technologies.

The table below shows several methods for selecting and evaluating technologies, which have been used in various decision-making issues, such as evaluating technology offerings, information systems, and research and development.

Table 2: Various types of technology selection and evaluation methods for certain decision-making issues

Technology selection and evaluation method	The decision-making problem
Net present value method	Programming the selection of investments in technologies
Cost analysis (e.g. VNV, DCF and reimbursement)	Technology selection and evaluation
Unweighted ranking and model	Decision to select and evaluate investments in technologies
The analytical ranking process (AHP)	Selection and evaluation of industrial technologies
Multiatributive utility theory in combination with PRICE	Technology selection and evaluation
Linear and full programming	Technology selection and evaluation
Utility method-theory	Bidding decisions
The fuzzy overtaking method	Technology evaluation
Competitive bidding strategy model	Technology selection and evaluation

Multiatributive analysis in combination with regression models	Selection and evaluation of technologies for the public sector
Multicriteria selection and evaluation	Aggregation of expert judgments
The method of fuzzy preferences	Technology selection and evaluation
Fuzzy logic	Selection and evaluation of software technologies
Mathematical programming	The decision to select and evaluate the technology provider
Gray	Selection and evaluation of the technology offer
TOPSIS	Decision making for tenders
Fuzzy stochastic	Technology selection and evaluation
ELECTRE I	Technology selection and evaluation
The theory of possibility	Technology investment decision
Mathematical programming	Selection and evaluation of research and development technologies
Network Analytical Process (ANP)	Selection and evaluation of research and development technologies
Fuzzy-logic	Selection and evaluation of new product development technologies
ANP	Technology selection and evaluation
Packing method - several boxes	Selection and evaluation of research and development technologies
AHP and multi-attribute decision making technique	Selection and evaluation of industrial technologies
Mixed integrated programming method	Optimal selection and evaluation of the research and development portfolio
Zero-one integer programming methods with limited chance	Random selection and evaluation of technologies

As can be seen, there are different methods that are used for different decision issues. Therefore, it can be concluded that there is no specific method for a particular situation, but rather that there is a wide range of possibilities and applications. The advantages and disadvantages of the methods must be weighed against the particular issue of the available decision, in order to choose the most appropriate method. The table below explains some of the above methods, the corresponding advantages and disadvantages.

Table 3: Comparison of technology selection and evaluation methods

Decision method	Description of the method	Advantage	Disadvantage
Cost analysis (eg VNV, DCF and return on investment)	Use accounting data and other relevant information to identify ways to reduce costs and then choose the technology that works best	Controls costs and prevents waste and losses / Easy for decision makers	It focuses only on costs and ignores the cost-benefit principle
Linear programming	Linear programming is a technique for optimizing an objective linear function, subject to linear equality and inequality constraints	Get the best result in a mathematical model, give a list of requirements represented as linear equations	An optimal solution may not be found
Integrated programming	Type of mathematical programming whose variables are (in whole or in part) integers in the problem	It greatly reduces time and space for solution	More difficult to solve than linear programming
Fuzzy logic	Fuzzy logic is a form of multivalent logic derived from fuzzy theory, it deals with reasoning that is approximate rather than accurate	It is a powerful tool for managing inaccurate data	Fuzzy logic difficult to achieve on a large scale
AHP	A mathematical decision-making technique that allows the qualitative and quantitative aspects of decisions to be taken into account	Reduce complex decisions in a series of individual comparisons and then summarize the results	It depends on the experience of the expert / The comparison and the trial process is harsh, which cannot be used for high precision in decision making
ANP	It is a mathematical decision-making technique similar to AHP	It can deal with technology evaluation issues	It requires large amounts of data and the decision depends on the experience of the experts
Gray Target decision	Gray Target decision has some original effect on the problem of recognizing the model with small samples, insufficient information and data and in uncertain conditions	It does not need a large number of samples and the samples do not need to be regularly distributed / It can describe in more depth the nature of things with low computational load / The results of the quantitative and qualitative analysis will be more consistent / It can be used for short and long term predictions and is highly accurate	The optimal solution may not be a global optimization situation

While return on investment (ROI) is one of the primary factors for prioritizing technology, other issues should be considered,

such as alignment with strategy, balance between maintenance technologies and technology investments, allocation efficient use of resources and other non-financial benefits.

It is impossible to define a set of criteria suitable for all circumstances, as they will differ greatly from one another in different companies and technologies. As a result, there are an endless number of criteria mentioned in the technology selection and evaluation literature, which vary depending on the type of technology and methods used for selection and evaluation, where scoring methods present the most extensive and extensive set of criteria, including more than just financial and strategic issues. There are also different ways in which criteria can be organized, such as by the type of criterion, which is the most common.

3   CONCLUSIONS

Studying the literature has allowed us to understand the importance of selecting and evaluating technologies for the success of innovation and technology transfer in companies, but also the decision-making issues they face in applying the methods of selection and evaluation of technologies. The challenges arise because the methods available are usually too simple or too elaborate for most managers and companies to be systematically understood and applied. In order to tackle these challenges, the author developed a proprietary method, that includes criteria divided into several groups like financial, strategical, technological, marketing, and external factors, which could be adjusted for a concrete case. Due to the multicriteria

evaluation and selection approach, the new method permits to obtain of complex results with fewer efforts and special skills from the company technology managers.

To avoid further selection of technologies "Losers", the key lies in the objectivity of the selection and evaluation process, through a method that incorporates both financial and non-financial criteria and by the awareness that each method may be appropriate in certain situations for a particular company and for the circumstances of the technology. Such a method is proposed in the research conducted by the author of this article in his PhD Thesis „Selection and evaluation of technology for the technological transfer".

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