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Study on the policy of renewing product testing equipment to enhance competitiveness

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Abstract

The paper aims to analyze the need for change management strategy development in case of an organization wishing to replace its existing test equipment (software products) with newer and more advanced products. This has a positive impact both from the financial perspective and in terms of quality improvement of the product if the change situation is analyzed in the context of a related investment project implementation. With the increasing level of product complexity, there is a growing likelihood that these software products contain defects or errors, affecting customer satisfaction. The repairment cost of the product increases exponentially and in direct proportion to their lifecycle, from the development stage to the mass production phase. Therefore, our approach proposes to increase products (hardware and software testing equipment) quality by investing more in their performance which will positively impact the testing processes. The efficiency of the economic indicators calculation associated with the presented methodology will underline these issues.

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1. Introduction

Moran & Brightman (2001) have defined change management as "a continuous renewal of the capabilities, structure and direction of an organization to meet the changing needs of customers and market demands". Burnes (2004) considers that *change* is a permanent feature of organizational life, both operationally and strategically, so there should be no doubt about the importance of any organization's ability to identify where it should to be in the

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future and how to manage the changes needed to get there. Consequently, organizational change can not be separated from organizational strategy or vice versa (Rieley& Clarkson, 2001; Draghici & Draghici, 2006). Graetz (2000) has suggest that: "against the background of increasing globalization, deregulation, rapid pace of technological innovation, increasing labor force of knowledge and changing social and demographic trends, few argue that the main task for management today is the leadership of organizational change". Kurt Lewin, the *guru* of organization change, has three major contributions on explaining the link between change management and organizational development:

1. The process of *change planning* which includes four interrelated elements: field theory, group dynamics, action research and the three-step model of change (unfreeze, move, refreeze) (Burnes, 2004, Hornstein, 2015);
2. Demonstrating how *psychological theories could be applied* to studying and changing group behavior in the real world (Dent, 2002);
3. Underling and demonstrating *the need to promote democratic values and participation* in order to manage conflict (Hornstein, 2015).

Nowadays, researchers, consultant and academics have recognized that change management is strongly linked with organizational development or dynamics and arguments have been given by consensus on highlighting the relevance and importance of values and the behavioral/social sciences (Kolodny, 2004; Burnes& Cooke, 2012; Hornstein, 2015). Even the concepts were considered synonymous, and Levasseur (2010) suggests that the active use of their most effective models, methodologies and processes have potential to improve "the odds of project success" (p. 159).

In the context of the paper there will be presented the case of integrating the investment project (with some particularities of the decision-making process) with a change management process related to the case of an organization wishing to replace existing test equipment (software products) with newer and more advanced products. Furthermore, some possible investment risks will be considered and estimated and some particular project evaluation method will be applied. The outcome of an investment project evaluation depends on three variables: time, liquidity and risk mitigation aspects. The risk assessment process for investment projects is necessary to avoid delays and losses in all categories (Sarca et al., 2016).The implementation of the investment project should have the capacity to generate profit, and should therefore allow the overall return on investment. The main features of the investment project should be strongly connected with following issues:

- Strategic investments that represents the company's strategy and refers to various alliances between the company or the creation of a new product/service;
- Investments by upgrading existing capacity or organizational processes refer to investments in the means of production produced in order to increase productivity and to reduce working time;
- Investments in human capital development are associated with the highest risk and uncertainties rates, and usually refers to employees' competencies and skills development through specialized training programs.

The presented research will full-fill the knowledge gap of the literature regarding the decision-making process in the case of investment projects. There have been recognized that the decision-making process complexity requires a welldocumented preliminary stage and a strategy for obtaining as much information as possible (Ford & Richardson, 2013; Pettigrew, 2013;Shepherd & Rudd, 2014). All actions (documentation, estimates and calculations) have to be planned, but well-defined steps have been followed, included in a well-defined methodological approach.

The proposed approach for the investment project integration will be demonstrated in the case of acompanythat needs the increasing level of product technology. Therefore, the researchproposes to increase products (hardware and software testing equipment) quality by investing more in their performance which will positively impact the testing processes, thus enhancing the ability to create products of high quality. The mathematical model associated with the presented approach will underlined these issues.

2. Methodological approach

The previous work of (Sarca et al., 2016) has described in generally, how some classical methods and tools can be combined in order to fundament the decision-making process in the case of an investment project. The preliminary presented methodology has only make the preparation for the economic efficiency analysis of the potential investment projects. Thus, the aim of the presented research is to show how the hierarchy of the potential

investments projects can be established based on the calculations of the economic efficiency indicators. The proposed methodology is shown in Figure 1. The practical context of implementing investment projects starts with the investment specification (description of the objectives, functionalities to be realized and the users' needs) in order to establish the legal framework of the tender.

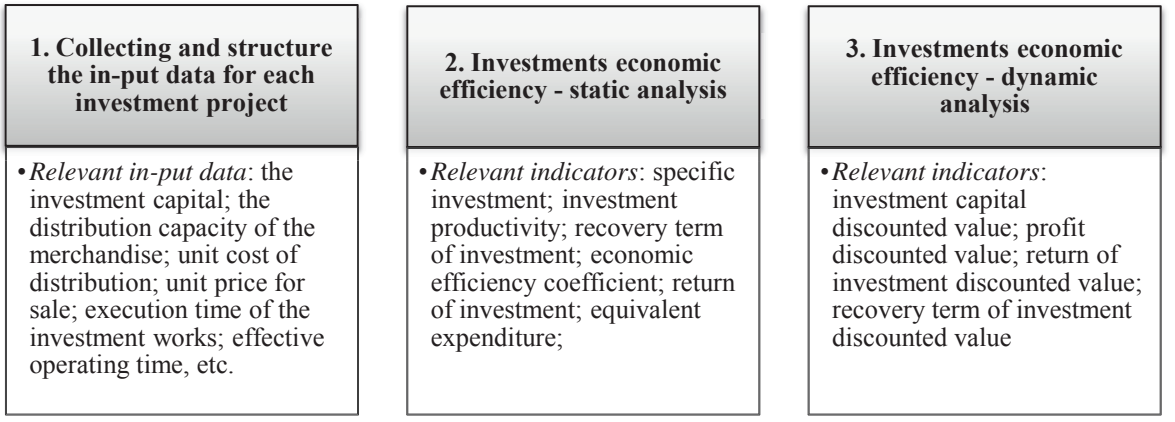

Fig. 1. The proposed methodology for establishing the investment projects hierarchy.

The proposed methodology consist of three steps. First, the relevant in-put data are collected for each provider in charge with a project implementation (actor of the tender process). Several developers, builders, or equipment vendors can participate in the auction, each with its own vision of how to make the investment. Thus, considering the case of at least three investment projects (or offer), of interest are technical-economic indicators, as shown in Fig. 1. Based on the collected data there can be developed steps two and three of the methodology or the static and dynamic analysis of the investment projects. Finally, the economic efficiency indicators results will establish a hierarchy of the investment projects which is the framework of the decision-making process on choosing the optimal solution or project that will be implemented. Additional explanations on steps two and three of the methodology will be provided during the case study section of the paper.

3. Case study: How to choose the best investment project?

The proposed methodology (Figure 1) will be demonstrated in the case of a company providing electrical and electronic equipment for motor vehicles and motor vehicles such as: generators, alternators, spark plugs, ignition conductors, electric systems for doors and windows, assembling of measuring devices (instrumentation) in instrumentation, regulators voltage, etc. In the last two years, the company has been extend its activity with a new software development department. The quality audit of last year has underlined key nonconformities of the processes in these area and the need for eliminating dominant nonconformities and increasing the software testing and quality control processes.

Started from this fact, the company has identified an urgent need for upgrading (modernization) the testing and control laboratory. This changing process has to be supported by an investment process defined by the implementation of a specific (optimal) investing project. After the investment specifications' definitions, three providers have been interested in developing the investment project; each of them have their own vision and plan, and different strategic option in defining the investment objective (in accordance with the required specifications, their projects were presented in the tender process).

The following three projects were analyzed in order to choose the best option (see addition economic indicators presented in Table 1):

- Project 1 consists ofreplacing existing equipment with new, more performant and with addition functionalities which can assure the high qualityof the software testing processes; the total cost of investment was 320,000 EUR;

- Project 2 consists of purchasing new software testing and control equipment and maintained the existing ones only for preliminary or first quality process control; the total cost of investment was660,000 EUR;
- Project 3 was describing the creation process of a newthe testing and control laboratory (with new equipment and facilities); the total cost of investment was 640,000 EUR.

Table 1 In-put data for the three investment projects considered in the analysis.

Indicator	Symbol	Unit	Project 1	Project 2	Project 3
The investment capital	Inv	EUR	320,000	660,000	640,000
The production capacity (estimation)	Cd	pc/year	21,360	35,850	38,150
Unitary cost	C	EUR/pc	11,600	11,600	11,600
Unitary price	P	EUR/pc	22,500	22,500	22,500
The execution time of the investment	d	years	1	2	4
The effective operating time	De	years	10	10	10

During the organized tender process for choosing the optimal investmentsproject to be implemented, the decision making process has been of priority interest. It has been based on theeconomic efficiency analysis for the three possible investment projectsthat are characterized by the input data shown in Table 1.

Step two of the proposed methodology (the static analysis of the economic efficiency)is based on the calculation of relevant indicators, which are meant to characterize the amounts spent for each investment projects, reflecting the progress of activities, underlined the strengths and weakness of them, as shown in Table 2. Related to each economic indicator analysis, the score 1 was given for the optimal values of the calculated indicator. The total score was calculated by summing the individual scores gained by each investment project per each indicatorincluded in the analysis. The calculation process has been supported by Excel software tool.

Table 2 Indicators of economic efficiency of the investment projects- the static vision of the calculations

Indicators	Symbol	Unit	Project 1	Project 2	Project 3	Score 1	Score 2	Score 3
The investment capital	Inv	EUR	320,000	660,000	640,000	1	0	0
The execution time of the investment	d	Years	1	2	4	1	0	0
The effective operating time	De	Years	3	3	3	1	1	1
Specific investment	si	EUR/pc	1498.13	1841.00	1677.59	1	0	0
Investment Productivity	Iwi	pc/EUR	667.50	543.18	596.09	1	0	0
Annual Incomes	Vh	EUR	480.6	806.625	858.375	0	0	0
Annual Cost of production	Ch	EUR	247.776	415.86	442.54	0	0	0
Annual Profit	Ph	EUR	232.824	390.765	415.835	0	0	1
Investment term of recovery	Ti	years	0.14	0.17	0.15	1	0	0
The economic coefficient of investment	ei	-	7.28	5.92	6.50	1	0	0
Return of Investment	Ri	-	20.83	16.76	18.49	1	0	0
Equivalent expenditures	ki	EUR	775.328	1313.58	1391.62	1	0	0
Annual equivalent expenditures	ka	EUR/year	258.44	437.86	463.87	1	0	0
Specific equivalent expenditures	ksi	EUR/year	12099.38	12213.67	12159.20	1	0	0
The hierarchy of the investment projects (maximum score = best project) – static vision						11	1	2

Based on the calculations results shown in Table 2, it seems that Project 1 (with a total score of 11) is the optimal one because from the perspective of different criteria associated with calculated indicators, the results show optimal values.

The static analysis of the indicators that support the decision-making processof choosing the optimal investment project has been followed by the dynamic vision calculations and analysis (results are shown in Table 3 by applying the discounting technique). These were included in the step three of the proposed methodology (Figure 1).The calculation process of the economic efficient indicators in the dynamic vision has been supported by Excel software tool.

Table 3 Indicators of economic efficiency of the investment projects- thedynamic vision of the calculations

Indicators	Symbol	Unit	Project 1	Project 2	Project 3	Score 1	Score 2	Score 3
The discounting factor	a	%	10	10	10	-	-	-
The investment capital – dynamic vision	Inv	EUR	32,000	66,000	64,000	1	0	0
Profit - dynamic vision	P*	EUR	395,464	663,735	706,318	0	0	1
Return of Investment - dynamic vision	Ri*		11.83	10.36	12.23	0	0	1
Investment term of recovery - dynamic vision	Ti*	years	1.04	1.12	1.01	0	0	1
The hierarchy of the investment projects (maximum score = best project) - dynamic vision						1	0	3

The dynamic vision of the economic efficiency indicators has take into consideration the effects of time upon the invested sum of money. The calculation results are more precisely and the time vision decreases the values of the return of investment and the term of recovery, which have been considered as the most powerful indicators for the decision-making process. As it can be seen from the calculation results included in Table 3, Project 3 has the biggest score (having the maximum level of the return of investment and the minimum value of the term of investment recovery which are optimal values) and thus the company has choose to approve and implement this investment process.

In the second step of the analysis, the change management process suggested, by the calculations results of the economic efficiency indicators related to the investment projects that were analyzed, was of small dimension (small changes related to the replacing of the existing equipment) but with a low efficiency in time (demonstrated by the dynamic analysis). Furthermore, the third step calculations results of the proposed methodology has demonstrate that small investments (with small investment capital that seems to be adequate in the first estimation) could be totally inadequate for the effective operating time (in this case for the next three years of the equipment operation and use). Calculations have demonstrated that Project 3 which is related to the creation of a new the testing and control laboratory (with new equipment and facilities) is a feasible one, by considering its positive implication on the whole effective operating time of three years.

4. Conclusions

The paper has presented a feasible methodology to analyze a change management situation in the case of an organization wishing to replace existing test equipment (software products) with newer and more advanced products. The analyzed change situation has been associated with the possibility of implementing an investment project which is expected to have a positive impact both from the financial perspective and in terms of the products' qualityimprovement.

In order to achieve the company's goal for improving the testing and control processes of the developed and provided software, three investment projects were analyzed. Economic efficiency indicators have been calculated from the static and dynamic perspective and with the support of two predefined Excel sheets. The designed methods and tool have been proofed valuable for the decision-making process associated with the change management process in the organization.

The study could be extended in order to include more economic indicators associated to other decision-making perspectives. In addition, the proposed methodology could be easy adopted for the case of other change management processes that can be developed by companies operating in different fields.

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