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A MODEL BASED ON TOPSIS FOR DECISION OF INVESTMENT IN STRATEGIC PLANNING OF ICT

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Strategic Planning (SP) in Information and Communications Technology (ICT) is essential for the success of investments in technology because it allows the mapping of the current scenario and predicts options for future action paths. Actions depends on the decisions about which investments to hold and the priority among them. In this context, we propose an analysis about the Decision Making problem involving strategic planning in ICT, considering elements such as the TOPSIS technique and multi criteria analysis method for ordination of options with evaluation of dependency on the priority of the ICT project actions. By means of a case-study, we identified the usage of TOPSIS in artifacts of the PETIC methodology. As a result, it was possible to prioritize thirty-four actions to be developed in five years of investments.

Keywords: PETIC, ICT Strategic Planning, ICT Investments, Decision Making

Introduction

On the current scenario of globalized economy, technology is considered an ally of the search for information that allows organizations to formulate better business strategies (Bharadwaj, El Sawy, Pavlou & Venkatraman, 2013). This way, organizations assemble technology as a source of important innovation, a crucial factor to the success of companies on the competitive aspect and making of value (Reik & Lindemann, 2014). Therefore, to streamline the decision making and obtain organizational wisdom applied to all types of companies become essential resources (İntepe, Bozdag & Koc, 2013).

It is important to highlight that only acquisition of technology will not necessarily result in increasing competitiveness of an organization. Nevertheless, disregarding the acquisition of technology may lead to loss of the productivity (Rębiasz, Gawel & Skalna, 2015). Therefore, if technology do not achieve the goal of assisting the organization in the process of decision making, they will not bring any significant profits to the core business. Therefore, it will be required to align investment in technology with strategic planning of the company.

We order to know what the right investment is, organizations demand to obtain information for decision making in short and long term. For this purpose, it is necessary to perform a Strategic Planning (SP) of the Information and Communications Technology (ICT) sector, enabling analysis about the weaknesses that must receive increased attention by companies.

On the one hand, decision making is an essential process in industry, including activities such as organization managing and strategic planning. This process becomes even more complex in the face of current social and economical dynamics of development, seeking to select a proper alternative among many options (Deng, Hu, Deng & Mahadevan, 2014). Hence, the models that systematize the process of decision making become not only necessary, but also essential for organization management (Chen, Liu, Wang & Augusto, 2013). On the other hand, strategic planning of ICT is based on results of ICT evaluations, which develops and adjusts orientation about informatization of the company, and makes efforts itself so the technology can have the right scale and costs (Yujie & Xindi, 2010). In this context, SP of ICT acts on the analysis of alternatives, by requiring development of logic methods to support the decision (İntepe, Bozdag & Koc, 2013).

In this paper, we propose a model that employs a multicriteria method, including analysis of dependencies on the prioritization of actions for decisions making for SP of ICT. We aim to simplify the process and make it independent of external knowledge, using actions already collected during the SP. As a result, and as a positive aspect, information will always be complete for decision making, since the information is part of the artifact created during strategic planning of ICT. In addition, the process is continuous for sorting of investments and not necessarily for the best investment, allowing for creating an sortedlist through analysis of a set of investment options.

This article aims at analyzing the Decision Making problem about SP in ICT, starting from the usage of TOPSIS with the evaluation of dependency on the prioritization of actions in ICT projects. Especially, we aimed to identify, through a case study, the use of TOPSIS in artifacts of the PETIC methodology, which consists of a set of resources for decision making. The reminder of the paper is organized as follows. Section 2 describes background and related work. Section 3 presents our approach. Section 4 describes the case study, showing the analysis and discussion about results. Finally, Section 5 outlines conclusions obtained about the case study, pointing out possible outcomes in future works.

Background and related work

The process of decision making is a tedious task to create solutions to problems, including the identification of the best alternative. Decision making can be realized in different ways, including analysis of the situation, development of alternatives, comparison of alternatives, rating of risks, selection of the best alternative, and execution and evaluation about the decision (Albright, Christian & Winston, 2014). Among the existing models for decision making, multicriteria techniques are applied when it is necessary to analyze several criteria that can be conflicting when making the decision (Huang, Chen & Chang, 2015). In the face of the various existing techniques for decision making, eight multicriteria methods are identified by Chai, Liu and Ngai (Chai, Liu & Ngai, 2013), as shown by Table 1.

Table 1: Summary of the decision making techniques

Techniques of decision taking used	Abbreviation
Multi criteria techniques of decision taking 1. Analytic hierarchy process	AHP
2. Analytic network process	ANP
3. Elimination and choice expressing reality	ELECTRE
4. Preference ranking organization method for enrichment evaluation	PROMETHEE
5. Technique for order performance by similarity to ideal solution	TOPSIS
6. Multi criteria optimization and compromise solution	VIKOR
7. Decision making trial and evaluation laboratory	DEMATEL
8. Simple multi attribute rating technique	SMART

Considering the related techniques, TOPSIS is adopted in this study, to the base of a multicriteria model that acts on the ordination seeking the ideal solution. TOPSIS is in line with the aim of our approach that is to ordinate the relative investments of strategic planning actions of ICT.

TOPSIS, created by Yoon and Hwang, in 1980, applies the distance between the real solution and the ideal as a start point for the choice of a solution considered preferable, from a mathematical point of view. Therefore, TOPSIS is a method of analysis of multicriteria decision that allows for the ordination of alternatives using quantitative and qualitative criteria. These criteria reduce the number of alternatives to be initially considered (Dymova, Sevastjanov & Tikhonenko, 2013). TOPSIS is composed by a set of alternatives to be analyzed, which are evaluated based on the criteria under ponderosity assigned before their matter for the decision making (Dymova, Sevastjanov & Tikhonenko, 2013) (Hwang, Paidy, Yoon & Masud, 1980).

Among the references about the process of decision making for investments in ICT, the considered papers are of Rebiasz, Gawel and Skalna (Rębiasz, Gawel & Skalna, 2015), Nouri, Esbouei and Antucheviciene (Aliakbari Nouri, Khalili Esbouei & Antucheviciene, 2015), Parvaneh and El-Sayegh (Parvaneh & El-Sayegh, 2016), Avery et al. (Avery, Greenwood & Michalewicz, 2008) and Liao et al. (Liao, Yin & Chiang, 2009). These papers were chosen for being studies that deal mainly with the decision about the investment of ICT.

The paper of Avery et al.(Avery, Greenwood & Michalewicz, 2008) proposes a description referring to the difficulty of predicting the strategy of decision making from options opposing to when the strategic decision is taken. The proposed model by these authors evaluates the intelligence for the decision making as a game of opponents, using a co-evolutionary system to obtain the learning about the decision. Therefore, it is important the usage of previous data on the strategic decision making.

Liao et al. (Liao, Yin & Chiang, 2009) have the description of real options to improve the way of thinking about the evaluation and strategic decision about the investments in ICT, replacing traditional methods. These methods consist in transferring the investment in strategic technology to a kind of real option, combining a number of projects as part of an investment plan. That way, the Game Theory is integrated to the method of real option, mulling about a possible strategy of investment among the competitors by the concept of balance, and obtaining a model of investment considered ideal for the companies.

The paper of Rebiasz, Gawel and Skalna (Rębiasz, Gawel & Skalna, 2015) presents a model of evaluation for the selection of projects for investment divided into two steps that combine the AHP diffuse method and the Fuzzy Topsis method, starting from the definition of criteria and the assignment of ponderosity. AHP is used for calculation and construction of the matrix and classification using the Fuzzy Topsis,

being used to rank potential projects. The authors claim that it is required more research to examine the interaction and dependency of projects during the ordination.

Nouri, Esbouei and Antucheviciene (Aliakbari Nouri, Khalili Esbouei & Antucheviciene, 2015) claim that the selection of a technology is a complex multidimentional problem that employs several qualitative and quantitative factors that can be in conflict among themselves. Therefore, they present a hybrid model using the Fuzzy ANP (Analytic Network Process) together with FTOPSIS (Fuzzy Technique for order preference by similarity to ideal solution), and apply the result in a case study, seeking to validate the proposed model. The model seems to be effective in the process of indication, however it does not address the dependency of options, indicating that this study can be after enlarged, also indicating the usage of new approaches as the DANP.

On Parvaneh and El-Sayegh's (Parvaneh & El-Sayegh, 2016) paper, the authors propose a framework combining the AHP and LP methods, noticing qualitative and quantitative criteria and seeking the optimization of the selection based on the available budget. The model ensures the consistency on the decisions, ensuring the alignment of the decision of the selection based on criteria defined during the process. This is a theoretical research, which was not applied in a practical context.

The related papers, after analyzing the decision making process for investments in ICT, seek to identify the best option. Thus, the paper of Avery et al. (Avery, Greenwood & Michalewicz, 2008) and Liao et al. (Liao, Yin & Chiang, 2009) employ a financial model for project analysis using external and internal information for decision making. Papers of Rebiasz, Gawel, Skalna (Rębiasz, Gawel & Skalna, 2015), Nouri, Esbouei, Antucheviciene (Aliakbari Nouri, Khalili Esbouei & Antucheviciene, 2015), Parvaneh, and El-Sayegh (Parvaneh & El-Sayegh, 2016), employs multicriteria models to support decision making. However, they did not consider dependencies related to the projects. In this context, we have formulated the following research questions to guide our research:

1. RQ1: Can the proposed model prioritize the investments, reducing the risks, minimizing the initial costs of investments and maximizing the benefits?
2. RQ2: Having a group of actions to be prioritized, what is the result of this investment prioritization?

Our Petic-Based Approach

To address the aforementioned research questions, we have developed a PDM model to support decision making based on TOPSIS. PDM (PETIC Decision Making) is a support model for multi criteria decision making, which aims to reduce uncertainty on the process of ordination and selection of investments. Thus, it does not allow double interpretation on the indication of the preferable considered option, being created to decide about the ordination of the artifact actions of PETIC.

The PETIC methodology combines methods and techniques to conceive a strategic planning on ICT, being created by the Research Group of Software Engineering of the Federal University of Sergipe -UFS in 2008. PETIC acts on the analysis of the current environment and on the creation of an artifact of strategic planning to define acquisitions, priorities and resources to be implemented or acquired by the organization.

The PDM improves the PETIC model, with basis on TOPSIS and being applied to PETIC actions. It has a workflow (Figure 1) that starts with the elaboration of objectives of decision, and concludes with the ordinated list of preferences. On that workflow, steps 1 and 8 are continuous cycle, they are new adaptations related to PDM; whereas steps 2 to 7 are directly inherited from TOPSIS.

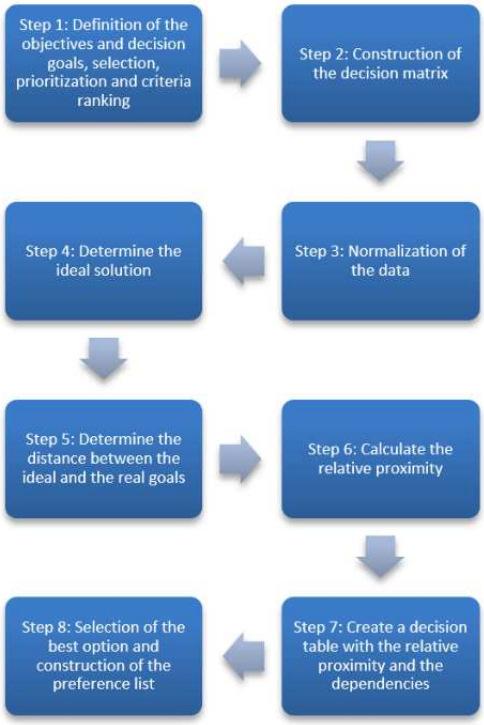


Figure 1: Cycle of PDM activities

PDM acts on the indicated alternatives of the strategic planning of ICT, creating an ordination of preferences. As follows, we described the steps of PDM:

Step 1: Definition of the objectives and decision goals, selection, prioritization and criteria ranking.

On this step, decision objectives must be defined, which will influence upon on the selection of the criteria and their ponderosity. The objective is to reduce costs and increase benefits. This way, it is employed all ten criteria proposed on PETIC (Table 2) plus the dependency criteria. The first ones can be changed, expanding or reducing

itself according to the objectives of the decision. But the dependency criteria are beholden to PDM.

Table 2: Set of 10 criteria of PETIC 3.0 with their types and attributes

ID	Criteria	Type	Attribute
C1	ROI	Benefit	0-4
C2	Standard Requirement / Law	Benefit	0-4
C3	Prevents infrastructure collapse	Benefit	0-4
C4	Strategic alignment	Benefit	0-4
C5	Main stakeholders / benefited	Benefit	0-4
C6	Cost	Cost	Monetary value
C7	Involved risks	Cost	0-4
C8	Probability of delivery	Benefit	0-4
C9	Effort	Cost	0-4
C10	Optimization of the resources	Benefit	0-4
Cdep	Dependencies	Dependency	Quantity of the dependencies

After defining the criteria, it is necessary to select the type that can be cost, benefit and dependency. It will be required the indication of ideal solutions. Therefore, at the end of the step, we will have a set of criteria denoted by $C = \{Cc|c = 1, \ldots, m\}$. Each criterion may have a weight, from 0, irrelevant criteria, to 100, extremely important. This weight is represented by $W = \{Wjj = 1, \ldots, m\}$,creating the graphic of information to decision Figure 2, and indicating the percentage of importance of the criteria to the choice. The graphic of importance presents a form of analysis of each criterion and it's weight on the decision, that can be altered based on the W variable.

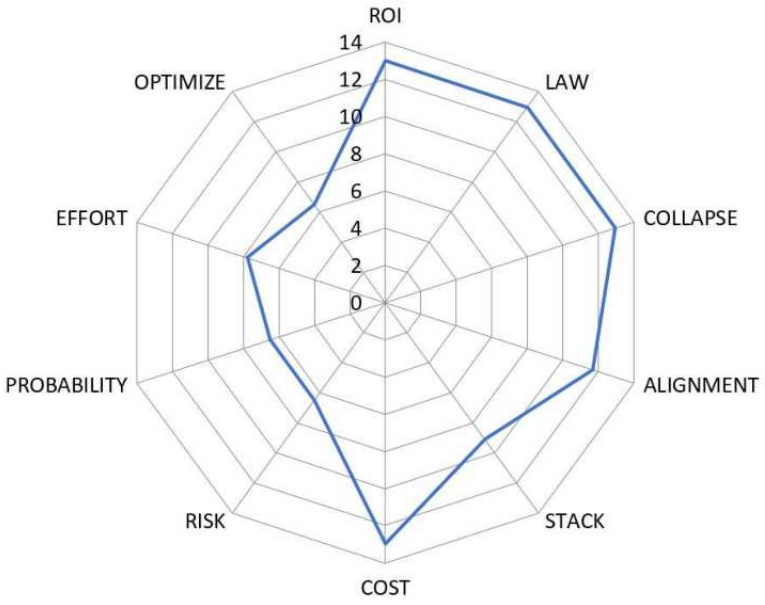


Figure 2: Grade of importance of the decision's criteria

Step 2: Building the decision matrix

After the definition of the criteria and their weights, it will be necessary to select the alternatives to be used on the analysis. It will demand the score of attributes to build the decision's matrix (equation 1). The alternatives are represented by A = {Alc|[= 1, ...,n;c = 1, ...,m}, having values to each one of the criteria, and indicating their impact, as shown in Table 3, as follows.

Table 3: Impact of the PDM criteria

Impact	Numeric scale
0	Nonexistent
1	Low
2	Moderate
3	Medium
4	High

Once alternatives are obtained, their criteria and weights, it will be built a decision matrix, represented by PDM. As shown in equation figure 3, as follows.

$$DM = \begin{matrix} \square \\ \square \\ P_1 \\ P_{...} \\ P_l \end{matrix} \begin{pmatrix} C_1 & C_{...} & CC_m \\ W_1 & W_{...} & W_m \\ A_{11} & A_{lc} & A_{1m} \\ A_{...} & A_{...} & A_{...} \\ A_{l1} & A_{...} & A_{nm} \end{pmatrix}$$

Figure 3: Matrix of PDM decision

Step 3: Normalizing the data.

The next step on the PDM process is the normalization of the data, as shown by the equation Figure 4. It becomes required because of the fact that the values of the attributes on the matrix are not equal among themselves. So, the normalization will make it possible the comparison among the criteria in a similar way. The only attribute that it is not normalized is the one related to dependency.

$$CN = \frac{W_n \times a_{nl}}{\sqrt{\sum_{i=1}^{n} a_{ij}^2}} \quad \forall\, 1 \leq i \leq n \,\&\, 1 \leq j \leq l$$

Figure 4: Normalizing the data

Step 4: Determination of the ideal solution.

A solution is taken as an ideal solution according to its type, in accordance with the Table 3. The ideal solution when the criteria is benefit, here represented by C_j^+, is given by the highest value, in other words, the higher the benefit, the better. On the cost criteria, here represented by C_j^-, the inverse is true: the lower the cost, the better. This way, must define the ideal solution of benefit and cost for each criteria, finding a positive ideal solution (equation Figure 5), represented by SI_j^-, and a negative ideal solution (equation Figure 6), represented by SI_j^+.

$$SI_j^+ = \begin{Bmatrix} Máx\,(A_{1j}, A_{2j}, \dots, A_{nj}) & Se\ C_j \in C^+ \\ Mín\,(A_{1j}, A_{2j}, \dots, A_{nj}) & Se\ C_j \in C^- \end{Bmatrix}$$

Figure 5: Positive ideal solution (better solution)

$$SI_j^- = \begin{Bmatrix} Mín\,(A_{1j}, A_{2j}, \dots, A_{nj}) & Se\ C_j \in C^+ \\ Máx\,(A_{1j}, A_{2j}, \dots, A_{nj}) & Se\ C_j \in C^- \end{Bmatrix}$$

Figure 6: Negative ideal solution (worst solution)

Step 5: Determination of the distance between the ideal and the real

For each one of the options it will be required to calculate the distance between the current value of the criteria and the ideal solution, being used for that the calculus of Euclidian distance, as well for the positive , represented by DSI_i^+, as the negative, represented by DSI_i^-. The Euclidian distance corresponds the smallest distance between two points (Hwang, Paidy, Yoon & Masud, 1980) Figure 7.

$$DSI_i^+ = \sqrt{\sum_{j=i}^{i} \left(CI_j^+ - C_{ij}\right)^2}$$

Figure 7: Calculus of the Euclidian distance for the ideal positive solution)

Step 6: Calculus of the relative proximity.

On this step, for each alternative, it is calculated the relative distance (equation figure 8), represented by **ξ**. The relative proximity will determine the order of classification, that means: the higher the value is, the more preferable the alternative is

$$\xi = \frac{d_i^-}{d_i^+ + \quad d_i^-}$$

.

Figure 8: Calculus of the relative proximity

Step 7: Creation of the decision table, with the relative proximity and the dependencies.

Having the relative proximities of each one of the alternatives and with the dependencies, a decision table as Table 4 should be built to simplify the selection.

Table 4: Decision table relative proximity X dependency

Alternatives	Relative proximity	Dependencies
A1	ξ1	0
A2	ξ2	0
A...	ξ...	1
Ai	ξ	0

Step 9: Selection of the best option and construction of the preference list.

One of the main contributions to this paper is to tackle the dependencies during the indication process, so, an option is preferable when her relative proximity is higher or equal to everyone's and the dependency is equal to zero, being given by the equation figure 10. After each preference selection it is required to return to step 7 (Figure 9), verifying the existence of dependency among the selected alternative and the others. If so, the dependency is eliminated.

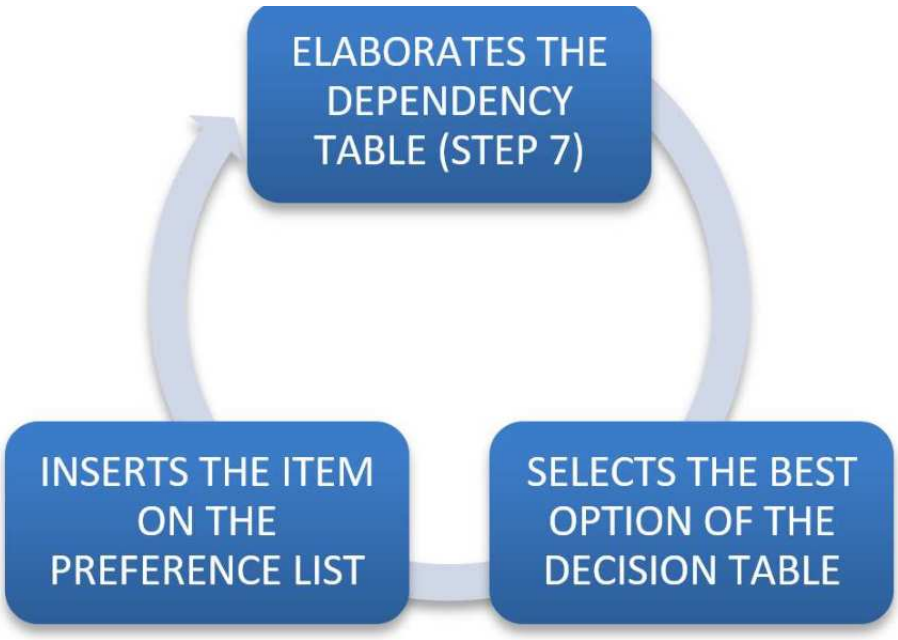


Figure 9: Cycle of action prioritization

During the cycle of elaboration of the decision table, the manager is free to select the items of the matrix by subjective reference and insert directly on the preference list, so, at the end, it is intended to obtain a preference list given as: PSi ≥ PSi ≥ PS...

$$PS = \{A|\max\ \mathrm{A}(\xi)\}\ \&\ Dependency = \{A|A(Dependency) = 0\}$$

Figure 10: Selection of the best alternatives, having the relative proximity maximized and zero dependency

Evaluation

This section aims to assess our approach and describes the case-study conducted in this research. The general objective consisted in characterizing the functionality and the efficiency of the PDM on the prioritization of actions of strategic planning, based on PETIC. Therefore, the objective of the research was formalized using part of the GQM model (Wohlin et al., 2012): analyze the application of PDM on indications of prioritization about the actions, with the evaluation goal, related to the selection of preference in ICT investments, from the point of view of the managers and analysts on the context of implementation of strategic planning.

Planning

The research questions, applied in a case-study of the Processing Data Center (PDC) of the Syndicate of Secretary and Office Clerk of the State of São Paulo (SINSESP)[1] , were:

Q1. Can the proposed model prioritize the investments, reducing the risks, minimizing the initial costs of investments and maximizing the benefits?

Q2. Having a group of actions to be prioritized, what is the result of this investment prioritization? Facing these questions, the established hypothesis for the study was:

H0 non-existing: The PDM does not allow the evaluation of the competition among the actions to investment prioritization.

H1 alternative: The PDM allows the evaluation of the competition among the prioritization actions of investment.

Description of the places where the case-study was conducted

The Processing Data Center (PDC) of SINSESP has the objective of implanting and giving support the policy of ICTs on the organization, reducing costs and optimizing the benefits of ICT applications. The unit is organized in Technical Support, Networks and Systems, counting with three staff. On the institutional context, the PDC has the objective: [...] attend the internal/external clients with better agility, within the

[1] https://sinsesp.com.br/

international standards of quality, employing continuous improvement process giving better tools and work environment to the contributors" (SINSESP, 2015), and it's vision [...] is to be reference in TI Union on the state of Sao Paulo, expanding the source of innovation and multiplying the commitment and maturation of the team" (SINSESP, 2015).

Preparation

To perform the prioritization in the case-study, we initially analyzed strategic planning based on PETIC between the period of June to July of 2017 on SINSESP. It was realized interviews with the responsible of PCD and two analysts of the sector, with the project director and the president of the institution. At this moment, all six areas covered by PETIC were discussed and analyzed: Data, Software, Hardware, Telecommunications, People and Governance, resulting in a total of 133 processes to be analyzed. To address this issue, we used the mobPETIC1 app[2]. The stored data enabled the achievement of the tests of equations to prioritize the investments. For the application of PDM step was used the PDMSys2, tool for application of PDM (Rocha, da Silva, da Paixão, do Nascimento, 2017).

Case-study execution

After the analysis process realized during the strategic planning, we identified that out of the 133 processes, 105 were interesting for the institution and 28 failed to be interesting at that moment. For all marked 105 processes gain maturity, 34 actions were approved, which gave support for process improving (Table 5). These 34 actions were ordered and evaluated employing the PDM model.

[2] https://github.com/petic/mobiPETIC

Table 5:Table of processes and actions per PETIC area and improvement actions per area

Area	Total of PETIC processes	Total of contemplated processes	Total of not contemplated processes	Total of improvement actions
Data	17	10	7	4
Software	24	20	4	5
Hardware	11	6	5	6
Telecommunication	20	13	7	6
People	15	10	5	3
ICT Governance	46	46	0	10
TOTAL	133	105	28	34

For the sake of clarity PETIC criteria were utilized, having the weights assigned as the PDC objective, Figure 11: ROI weight 10 - C1; Law requirement weight 10 - C2; Avoids the collapse weight 10 - C3; Strategic alignment weight 9 - C4; Main stakeholders weight 7 - C5; Cost weight 10 - C6; Risk involved weight 5 - C7; Probability of delivery weight 5 - C8; Effort weight 6 - C9 and Optimization of the resources weight 5 - C10. After the application of PDM we carried out individual interviews with the team to analyze the results, as well as a meeting with everyone involved for discussion of the applicability of the model.

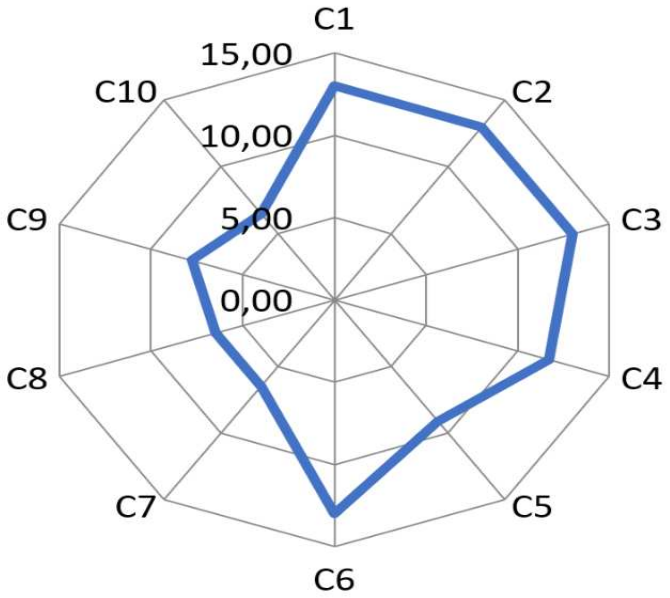


Figure 11: Importance of the criteria for decision taking

Hence, based on the criteria, it was applied the PDM on the 34 actions (Figure 12), identified during the strategic planning of ICT.

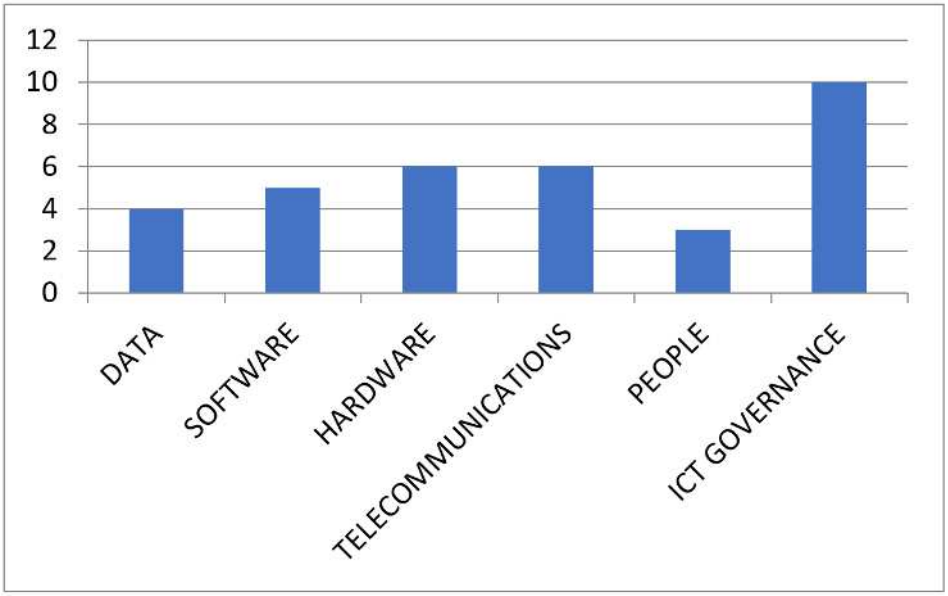


Figure 12: Actions per area raised on the strategic planning

At the end of the PDM execution, the 34 actions were classified by their importance and dependency, as the generated preference list, creating the sequence as follows: $A1 \succeq A_{12} \succeq A_{29} \succeq A_{34} \succeq A_{25} \succeq A_{10} \succeq A_3 \succeq A_2 \succeq A_{22} \succeq A_{23} \succeq A_{24} \succeq A_{13} \succeq A_4 \succeq A_{28} \succeq A_{32} \succeq A_{21} \succeq A_{18} \succeq A_{14} \succeq A_6 \succeq A_{30} \succeq A_{27} \succeq A_{27} \succeq A_{20} \succeq A_{15} \succeq A_7 \succeq A_5 \succeq A_{11} \succeq A_{16} \succeq A_{33} \succeq A_{31} \succeq A_{19} \succeq A_{17} \succeq A_8 \succeq A_9$

Based on the criteria of decision making it is possible to conclude that the alternative A1 is the one preferable for the investment. The alternative A9 might be the last option to receive investment, since it's preference is the smallest one.

As the interview with the project coordinator (responsible for the release of the funds), the PDM application enabled the predictability of the wastes, since the labor income comes, mostly, from the funds released just once a year, being required to know beforehand how much will be invested. Regarding institution president, the result helped on the visibility of PDC improvement and also, to know which aspects are needed to request a better effort from the PDC manager for future improvement. For the PDC manager, the PDM enabled the planning of sector outlay. The two analysts that compose the ICT team, claim that the model could elaborate new action proposals, since they started to know the decision criteria. According to the interviewed, the model also let them aware about what should be targeted as new projects. The other highlighted point of view is that there were not anticipated costs. In other moments, due to the lack of dependency analysis, it occurred financial expenditures for unnecessary actions. Therefore, the model helped on the investment vision, avoiding anticipated

spendings. Thus, we are able to answer the research questions initially proposed for the investigation:

RQ1. Can the proposed model prioritize the investments, reducing the risks, minimizing the initial costs of investments and maximizing the benefits?

The model showed itself as functional, being applied to a set of 34 actions for five years of planning, a total of 105 processes. However, it is necessary the realization, in first instance, of the prioritization of the criteria for the decision taking, and the indication of values for each on of the criteria. Thereby, the indications could be done with complete information. The absence of complete information will disrupt the prediction of the prioritization. After the prioritization, it was generated the preference list focused on the reduction of the costs and improving of the benefits with zero dependency.

RQ2. Having a group of actions to be prioritized, what is the result of this investment prioritization?

With the ordination model of actions, based on the plannings, it is possible to identify when it will be required a specific task creating an sorted list of actions. Thereby, it will be possible to predict the necessary investments. It is observed, ergo, that TOPSIS, together with the validation of the dependencies, allows for the ordination of actions as competitors items, rejecting the non-existing hypothesis in favor of the alternative hypothesis. The model enables the prioritization of investments, however, it is applicable, currently, only to PETIC model due to it enables the quantitative evaluation. Although the case study has been applied only on SINSESP, the model shows a level of acceptable abstraction to the application on other institutions, independent of part or segment, since it employed the PETIC methodology. Still, according to SINSESP's board of directors, the model was satisfactory because it allows for controlling the investments through a long-term planning. This investment planning is crucial for the union that receives the financial resources of contributions once a year.

Conclusions

In this work, we have presented an approach based on TOPSIS for the recommendation of prioritization of strategic planning actions. The results have indicated that this theory allows managers to validate indications about the prioritization of PETIC improvement actions. The recommendation was treated as a rational prioritization problem of tasks through strategic. The case study carried out proved that it is possible to expand the benefits and reduce the costs with the PDM application. The results were promising and they pointed to the viability of the approach with similar results of the natural process, however with higher quality in relation to the cost and benefit analysis.

In comparative analysis about what was used to improve the decision making, about the investments in actions and projects of ICTs, and the proposed actions on the papers of Avery et al (Avery, Greenwood & Michalewicz, 2008) and Liao et al (Liao, Yin & Chiang, 2009), it is noticed the distinction related to the independency of the necessity of external analysis and the institutional context. However, in the papers of Rębiasz, Gawel and Skalna (Rębiasz, Gawel & Skalna, 2015), Nouri, Esbouei (Aliakbari Nouri, Khalili Esbouei & Antucheviciene, 2015) and Parvaneh and El-Sayegh (Parvaneh & El-Sayegh, 2016) there is a necessity of expanding the model to analysis of the dependencies not available in those five papers. While on the PDM model the aspect that puts itself as essential is the strategic planning elaborated with basis on PETIC. Therefore, through our proposed model it was possible to select the considered preferable alternatives and analyzing the dependencies, beyond creating a continuous cycle to ordinate alternatives. The case study proved the practicability of the method, avoiding indication where the dependencies could harm the investment. Nevertheless, it is highlighted that the use of the proposed method is limited by the requirement attributes that the alternatives must receive to analyze.

It is worth mentioning that the PDM model is a mathematical model wherein the necessity of negotiation and the human aspects can not be removed. So, the PDM should not be considered as golden truth, but as a support tool, which is guaranteed on the PDM execution cycle. Thus, managers can separate the projects that they consider more important. Thus, we think this paper contributes to an area of prioritization analysis, through a logic and objective process, making it clear the decision about investments.

As a future work, we plan to apply the PDM in a prior history-based stock indication system during strategic planning; And apply the PDM in new studies with organizations of different branches.

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