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Importance-Performance Analysis in Project Portfolio Management Using an IOWA Operator

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Abstract. Prioritization of activities is one of the many facets in digital products management. In this study, we propose an alternative point of view on Portofolio Projects Management, in order better understand their relationship between *performance* and *importance* and how resources can be allocated taking into account these two categories. An application of the presented methodology to a real use case in the Digital Department of SEAT S.A. is discussed to show current results and future developments.

Keywords. Information aggregation, Importance-Performance Analysis, IOWA operator, Aggregation function

1. Introduction

Digital businesses can face higher costs of development and R&D but they can also benefit of higher profit margin if the solution become successful compared to traditional businesses [6]. To foster this success, a great contribution is given by the AGILE framework, that allows new digital companies to build an effective and efficient working model since the very beginning.

On the other hand, traditional enterprises are pushed to invest conspicuous amount of resources (workforce, money, time) to keep up with the new digital organizations and convert their portfolio of products including more appealing, convenient and profitable solutions. Automotive manufacturers are examples of traditional enterprises that, until few years ago, were able to generate profit thanks to the bare sale of cars and spare parts. Nowadays, thanks to the digital transformation, they have the opportunity to widen their business channels and increase their profit margins [2].

As for digital startups, AGILE framework helps traditional firms in transforming themselves internally to ride the wave of the digital transformation. In this context, the version of AGILE for large enterprises is usually adopted, namely SAFe (Scaled Agile Framework for Enterprise). SAFe encompasses a set of practices, roles, duties that helps enterprises in managing and developing digital products portfolio [4].

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Prioritization of activities is one of the critical tasks in digital products management that is regulated and supported by SAFe with different, easy to implement, techniques. The most used one in prioritizing is the Weighted Shortest Job First (WSJF) method [7]. The WSJF is a well suited method to prioritize sub-activities (Features, User Stories) of wider projects/program. It takes into account the business value each improvement will provide once developed.

This WSJF methodology has been adopted also by the Digital Office of SEAT S.A. when prioritizing the set of portfolio projects that the company is going to pursue in the mid term (2022-2026). The objective of the prioritization task was to set priorities of the department at portfolio level, and obtain a first hint on which projects could have been discarded. For the sake of the purpose, the WSJF had been slightly adapted to meet the criteria available relatively to the original set of project. The result, however, did not meet the expectation of the management that negotiated some changes in the final ranking to reach a wider consensus.

The goal of this study is therefore to propose an alternative point of view on Portfolio Projects Management, in order better understand their relationship between *performance*and *importance* and how resources can be allocated taking into account these two categories.

The rest of the paper is organized as follows. In Section 2, the theoretical preliminaries are provided. Section 3 presents a real case application of the framework within the digital department of an automotive company. Finally, some conclusions and future research are discussed.

2. Preliminars: Theoretical approach

In this section, we briefly introduce the necessary concepts and the methodology for the approach considered. This approach adopts a hybrid solution, merging Multi-Criteria Decision Aiding, Importance Performance Analysis and Information Aggregation.

We consider two different categories of variables: variables related to the economic performance and variables related to the strategic importance of the activities.

The original setup therefore includes:

- The set of alternatives (activities or projects) to rank $A = \{a_1, a_2, ..., a_n\}$
- The set of economic variables $V_e = \{v_{e1}, v_{e2}, ..., v_{em}\}$
- The set of strategic variables $V_s = \{v_{s1}, v_{s2}, ..., v_{sz}\}$

For each set of variables, Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is adopted to assign to each alternative a global value of economic performance and a global value of strategic importance, $P = \{p_1, p_2, ..., p_n\}$ and $I = \{i_1, i_2, ..., i_n\}$ such that $p_j, i_j \in [0,1]$ for each $j = 1, ..., n$ [3].

Activity	Economic performance value	Strategic importance value
a_1	p_1	i_1
a_2	p_2	i_2
...	...	...
a_n	p_n	i_n

Table 1. TOPSIS similiarity values for Economic performance and Strategic importance

For a qualitative and visual interpretation of the values calculated, alternatives are reported into an Importance-Performance Analysis diagram [1], adopting the Economic performance values as x-coordinates and the Strategic importance as y-coordinates.

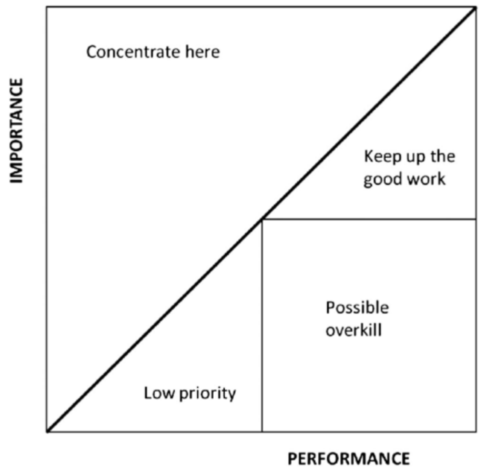

Figure 1. Importance-Performance Analysis diagram partition introduced in [1]

Unlike the traditional Importance-Performance Analysis, where the ordinal ranking position of alternative is reported into the diagram, the Importance/Performance similarity measures from TOPSIS are plotted.

After computing the two different, independent, values of Economic performance and Strategic importance for each alternative, an IOWA-based operator, presented in [5], is adopted to retrieve a global evaluation index for the portfolio: the $\mathscr{G}$-index. The objective of this index is to provide a global score of importance vs performance status of the whole portfolio, with a focus on under-performing alternatives.

By definition [8], an IOWA operator of dimension n is a function $\Phi : (\mathbb{R}\times\mathbb{R})^n \to \mathbb{R}$ such that

$$\Phi\big((u_1,x_1),\ldots,(u_n,x_n)\big) = \sum_{i=1}^{n} w_i x_{\sigma(i)} \tag{1}$$

where

- $\{u_1,\ldots,u_n\}$ is the order-inducing variable of the IOWA operator
- $\{x_1,\ldots,x_n\}$ is the argument variable of the IOWA operator
- $\sigma : \{1,\ldots,n\} \to \{1,\ldots,n\}$ is a permutation such that $u_{\sigma(i)} \geq u_{\sigma(i+1)}$ for $i = 1,\ldots,n-1$
- $\{w_1,\ldots,w_n\}$ is the set of weights such that $w_i \in [0,1]$ and $\sum_{i=1}^{n} w_i = 1$.

In this specific case, and as employed in [5], n is the number of alternatives considered whilst u_i and x_i are replaced by p_j and i_j, respectively.

The Importance vector of the alternatives assumes the role of Order-inducing variable while the Performance vector takes the role of argument variable. Consequently, the Importance-Performance (IP) vector of the initial set of alternatives becomes:

$$\big((i_1,p_1),\ldots,(i_n,p_n)\big) \tag{2}$$

with the tuple (i_1, p_1) belonging to the most important alternative with its associated performance and (i_n, p_n) related to the least important one with its corresponding performance value.

As previously stated, the $\mathscr{G}$-index focuses primarily on the under-performing alternatives, defined as items whose Performance value p_j is smaller than the Importance counterpart i_j. To account for this aspect, the Non-Negative Performance-Importance vector is calculated as

$$DV = (X_1,\ldots,X_n) \text{ with } X_j = max(p_j - i_j; 0) \text{ for } j = 1,\ldots,n \tag{3}$$

The $\mathscr{G}$-index is finally defined as:

$$\mathscr{G}(X_1,\ldots,X_n) = \sum_{j=1}^{n} w_j X_j \tag{4}$$

where the weights are represented by the normalized Importance vector, i.e. $w_j = \frac{i_j}{\sum_{j=1}^{n} i_j}$ for all $j = 1,\ldots,n$, so $w_j \in [0,1]$ for all $j = 1,\ldots,n$ and $\sum_{j=1}^{n} w_j = 1$. In addition, $w_j X_j$ represent the marginal contribution of the j^{th} alternative to the $\mathscr{G}$-index, with the contribution's magnitude varying according to its importance value i_j.

3. Application to a real case: SEAT S.A.

The proposed methodology and framework has been applied to a real case problem within the Digital Office of SEAT S.A. The problem setup involves a set of 14 activities to be ranked taking into account 7 variables, categorized into economic variables (3) and strategic variables (4). The aforementioned 14 activities will be pursued by the Digital Office in the mid-term (2022-2026). For this reason, the values available for the economic variables are estimations provided by the management, while the strategic variables reflect the current importance that a project have for the department. Projects' names, variables' values and names have been omitted due to confidential information.

	Economic performance variables			Strategic importance variables			
	v_{e1}	v_{e2}	v_{e3}	v_{s1}	v_{s2}	v_{s3}	v_{s4}
$Project_1$	$v_{e1,1}$	$v_{e2,1}$	$v_{e3,1}$	$v_{s1,1}$	$v_{s2,1}$	$v_{s3,1}$	$v_{s4,1}$
...	...	...	...	...	...	...	...
$Project_i$	$v_{e1,i}$	$v_{e2,i}$	$v_{e3,i}$	$v_{s1,i}$	$v_{s2,i}$	$v_{s3,i}$	$v_{s4,i}$
...	...	...	...	...	...	...	...
$Project_{14}$	$v_{e1,14}$	$v_{e2,14}$	$v_{e3,14}$	$v_{s1,14}$	$v_{s2,14}$	$v_{s3,14}$	$v_{s4,14}$

Table 2. Original dataset composition.

Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is applied to first identify, for the two categories of variables (economic and strategic), the Ideal and Anti-Ideal solution and subsequently calculate the relative Euclidean distance of each alternative with respect to the two endpoints.

The final values are:

	Economic Performance	Strategic Importance
Project1	0.160	0.447
Project2	0.615	0.588
Project3	0.462	0.200
Project4	0.486	0.700
Project5	0.100	0.313
Project6	0.000	0.447
Project7	0.816	0.413
Project8	0.256	0.700
Project9	0.454	0.800
Project10	0.226	0.700
Project11	0.000	1.000
Project12	0.130	0.800
Project13	0.081	0.656
Project14	0.044	0.568

Table 3. Similarity values for Economic Performance and Strategic Importance Obtained via TOPSIS

Similarity values are then reported into an IPA diagram to visually reflect the current importance-performance trade-off of the portfolio. The current diagram visually shows a condition of general under-performing portfolio. The majority of portfolio items fall within the area ”Concentrate here” of the considered partition of the IPA diagram while only a single item sits within the ”Keep up with the good work” section.

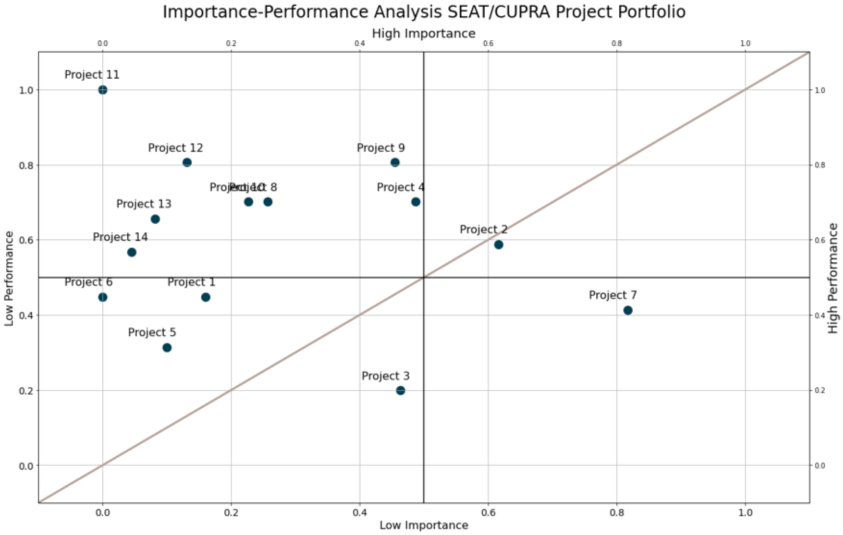

Figure 2. TOPSIS similarity values reported in IPA diagram

As previously defined in Equations 3 and 4, the Non-Negative Difference values X_j, the weights w_j and the marginal contributions $X_j * w_j$ for $j = 1, \dots, n$ are calculated and reported in Table 4.

	Economic Performance	Strategic Importance	Non-Negative DV	Weight	Marginal Contribution $\mathscr{G}$
Project1	0.160	0.447	0,287	0,054	0,015
Project2	0.615	0.588	0,000	0,071	0,000
Project3	0.462	0.200	0,000	0,024	0,000
Project4	0.486	0.700	0,214	0,084	0,018
Project5	0.100	0.313	0,213	0,038	0,008
Project6	0.000	0.447	0,447	0,054	0,024
Project7	0.816	0.413	0,000	0,050	0,000
Project8	0.256	0.700	0,444	0,084	0,037
Project9	0.454	0.800	0,346	0,096	0,033
Project10	0.226	0.700	0,474	0,084	0,040
Project11	0.000	1.000	1,000	0,120	0,120
Project12	0.130	0.800	0,670	0,096	0,064
Project13	0.081	0.656	0,575	0,079	0,045
Project14	0.044	0.568	0,524	0,068	0,036

Table 4. Non-negative difference values, weights, and marginal contributions for each alternative.

Following the results shown in Table 4, the original IPA diagram shown in Figure 2 is modified taking into account the weight that each project has with respect to the entire portfolio set 3.

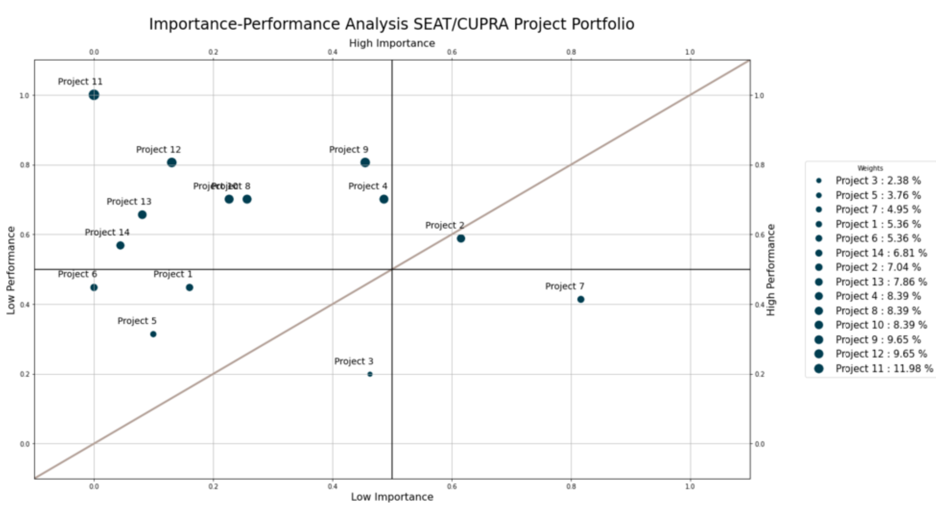

Figure 3. TOPSIS similarity values reported in IPA diagram with scatter points' size linked to alternatives' weights

Finally, to quantify the degree of under-performance, the $\mathscr{G}$-index as introduced in [5] is applied. According to the values of Table 4, the overall $\mathscr{G}$-index for this portfolio is 0,441. Note that accordingly to our approach, the optimum would be achieved when $\mathcal{G}(a_1,\ldots,a_n) = 0$.

4. Conclusions and future research

This paper proposes an alternative point of view on Portfolio Projects Management, in order better understand the relationship between performance and importance and how resources can be allocated taking into account these two categories. The final objective is to be able to identify, and provide, the right action(s) to take in terms of portfolio performance improvement, given a certain amount of resources available. The presented research is still an on-going research, for this reason there are still many features of the method that should be carefully revised and aligned with the Decision Makers.

The next challenges to be solved are the optimization problem related to the allocation of resources minimizing the $\mathcal{G}$-index as objective function and, the improvement of the IOWA operator weights contributing to the final $\mathcal{G}$-index calculation. Also, we plan to analyze and compare results with other OWA operators.

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