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ARTICLE

Investments analysis and decision making: Valuing R&D project portfolios using the PROV exponential decision method

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Abstract To support the assessment of R&D project portfolios and to establish a systemic model to carry multiple evaluations using the decision-maker knowledge, preferences and purposes we have developed an evaluation matrix and a new procedure based on the PROV exponential decision method which uses multiple utility functions modeled to establish a common framework from which we can determine the projects relative value. The presentation of this new procedure is the main focus of this article and numerical examples are presented to illustrate the proposed approaches to attain comprehensible results and to discover the most valuable R&D projects to support investment decisions.

1. Introduction

Research and development (R&D) is the predecessor of new knowledge, patents and technology which might be converted into new innovations, enhanced products or explicit or tacit knowledge. To select and prioritize the most promising R&D projects multicriteria evaluation methods can be employed to capture the value of far-reaching opportunities under high uncertainty. R&D investment decisions are usually taken based on data which is highly uncertain and often very inaccurate, with very unclear technical applications, life time expenditure and market outcomes (Eldermann, 2012). To prevail over and to overcome some degrees of uncertainty and risk inherent to R&D projects, we aggregated in an evaluation matrix, some of the main criteria used to prioritize R&D projects, and we proposed a new multicriteria procedure to create a predefined model to assess multiple projects considering the decision-maker knowledge, preferences and purposes. Among the most known multicriteria decision methods addressing the decision-maker preferences and objectives are the AHP, Analytic Hierarchy Process (Canada & Sullivan, 1989; Munier, 2011; Saaty, 1980, 2005), the ELECTRE, Élimination et Choice Traduisant la Réalité (Figueira & Roy, 2005; Rogers, 2001; Munier, 2011) and the PROMETHEE, Preference ranking organization method for enrichment evaluations (Brans & Mareschal, 2005; Munier, 2011). Foreseeing a convergent goal, we have other methods, such as the PROV Exponential Decision Method (Rocha, Tereso, & Ferreira, 2012). The proposed procedure to create a predefined model to assess multiple projects is based on this last method. The assessment matrix and the new procedure based on the PROV Exponential decision method are described in the following sections, where we define their scope and purpose and where we present its application procedure.

2. Evaluation matrix to assess R&D projects

The evaluation matrix to assess R&D projects was developed to assess far-reaching ideas and to capture the value

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of future opportunities under high uncertainty. This matrix converts available and prospective information on quantifiable criteria organized in aggregation groups with different relative weights purposefully defined to include tangible and intangible assets.

Knowledge intensive organizations usually have a portfolio of pending ideas and projects to which they can recur to develop current products or to seize new inventions, technologies or products. These portfolios can also be referred as the organizations strategic options (Eldermann, 2012).

Strategic options, like R&D project proposals, can be difficult to assess due to the uncertain future of their results and there may be no clear understanding of their innovations prospective market potential. Knowing the difficulty of assessing far-reaching ideas, evaluation methods can be better used by reviewing the organizations current resources, networks and purposes, making them present as a part of the evaluation method.

The evaluation matrix is structured in seven aggregation groups including dimensions linked to the organization resources, networks and business strategy.

A — Advancement status and engaged resources: the existence of previous R&D results supporting the need for further research, and the available infrastructures and human resources with the abilities and engagement required for the project development;
B — R&D final applications differentiation: the uniqueness of the technology pursued and their manufacturing potential and ease-of-use;
C — Applications relevance and time-to-market: the project prospective resulting applications and their relevance for the institution operational and expansion activities, and perceived or expected expressions of interest and time needed to display a marketable technology;
D — Competing research projects: the existence of concurrent R&D teams and their ability to raise resources;
E — Competing applications: the available alternatives of solution (if available) pursuing similar purposes;
F — Investment and operational costs of the R&D project: the required investment and operational additional costs with the R&D project after discounting public funds (if available);
G — Profitability: the prospective applications pursued by the R&D project net-present value, internal rate of return and pay-back-period.

In Table 1 is presented the aggregation groups and their relative criteria, established by reviewing the works of Eldermann (2012), Razgaitis (2003) and Speser (2006), and their proposed measuring scales are presented in appendix. A weights proposal is also suggested, just for the purpose of supporting the presentation of a numerical example, described on the third section of this article.

The criteria weights can be assigned directly to every criterion or a formal method can be used, such as the AHP weighing procedure (Saaty, 2005; Hobbs & Meier, 2003) where the weights are attained by establishing paired-wise comparisons.

3. Application procedure

The PROV Exponential Decision Method (Rocha et al., 2012) was developed to express the stakeholders knowledge, objectives and preferences to attain comprehensible results and to discover the most adequate solution for a problem or to accomplish a certain goal and the ordering and relative value of the alternative solutions (our options).

Through the modelation of the stakeholders thoughts and purposes this method allows to develop an informed evaluation having in mind all the options which are visually shown on a graphical representation. This graphical representation presents the options relative position on two lines, one expressing a linear growth which means that increments of the same size have equal importance, and another line expressing the real value attributed by the decision-maker having into account that as some milestones are attained, the importance attributed to greater values may decrease, since some value of satisfaction has been attained. It also allows the decision maker to express the interval of values at which he considers the options indifferent among each other. He can also express that the options in a determined interval of values have a closer importance and as they get away from this interval the value of those options decrease intensively. The decision-maker can also express the decrease of preference if, at a determined level the continuous growth becomes nefarious for the problem under analysis.

This method has been presented, by the authors of this article, on the Proceedings of the World Congress on Engineering 2012, on this current work, we're just going to present some of its steps and the concepts of nefarious values won't be addressed, since their content and features aren't required for projects portfolio assessment.

On the following description, we're also going to add new insights into the method on how to establish a common reference scale to assess the value of multiple projects by introducing new data into a predefined evaluation matrix. This procedure is going to be presented using the previously proposed evaluation matrix, and its application can be understood by following the subsequent steps. For the purpose of illustration, numerical examples will be used:

1st Identify the R&D projects, also referred as options, to be evaluated (for this purpose, we used seven hypothetical projects, represented by the letters A to G, within a research area, see Table 2);

2nd Review the R&D projects assessment matrix to check if all the relevant criteria, for the purpose of our analysis, are contemplated and make any change in accordance to that purpose;

3rd Identify the attributes for each project, by referring to the criteria measuring scales, presented in appendix, or to any other scale considered relevant and establish a matrix with those attributes, see Table 3;

4th Analyze the attributes, to verify if the lowest performance of some project, in fundamentally important criteria, makes them unacceptable (this should be done if we have crucial criteria demanding minimum standards to avoid possible compensation by other criteria; the projects below the minimum standards shouldn't be considered);

5th Determine or assign weights to the criteria. The weights can be assigned directly by the decision-maker or