Available online at www.sciencedirect.com
ScienceDirect
Computers and Chemical Engineering 32 (2008) 307–319
Computers & Chemical Engineering
www.elsevier.com/locate/compchemeng

Impact of tactical and operational policies in the selection of a new product portfolio

Juan Camilo Zapata[a,*], Vishal A. Varma[b], G.V. Reklaitis[a]

[a] *School of Chemical Engineering, Purdue University, West Lafayette, IN 47907, USA*
[b] *Air Products and Chemicals, Allentown, PA 18195, USA*

Received 1 November 2006; received in revised form 29 March 2007; accepted 30 March 2007
Available online 12 April 2007

Abstract

The effective management of a new product development (NPD) pipeline is critical to guarantee the survival of the organization in the long term while maximizing the creation of value. This is a challenging goal, due to one or more of the following factors: intensive research and development investment, long and uncertain development times, low probability of technical success, and uncertain market impact and competition. In NPD management, as in any other area, decision making is commonly broken down into three independent hierarchical levels: strategic, tactical and operational; where each level uses data and models whose degree of aggregation depends on their corresponding scope and their dynamic or static character. In principle, this decomposition strategy allows managers to concentrate on the variables that are relevant to each level and therefore generate decisions that will be reflected in optimal or near optimal performances. However, there are no empirical or theoretical results reported in the literature that validate this assumption. The aim of this study is to characterize the optimality gap between the set of decisions based on a decomposition strategy and those obtained by using a comprehensive decision support approach, in which the dynamics of all the different decision making levels are considered simultaneously. For that purpose a multi-phase, multi-level Sim-Opt decision support framework capable of accommodating any set of decision making levels with any degree of detail is proposed. A specific instance of the framework is used in the context of the pharmaceutical industry to determine the effects of considering the resource allocation strategies on the composition and prioritization of an NPD portfolio. Results show that if an integrated strategy is not considered it is not even possible to roughly estimate the performance of the pipeline for the chosen composition and prioritization. The performance of the portfolios selected using a tactical decision making strategy slightly different than the one implemented in the real system proved to be significantly suboptimal, off target and sometimes unreachable.

Keywords: Strategic; Tactical and operational decisions; New product development; Portfolio management; Risk; Sim-Opt; Discrete event simulation; Efficient frontier

1. Introduction

New product portfolio management is a key part of the dynamic decision process used by senior management to operationalize a business strategy (Roussel, Saad, & Erickson, 1991). It specifically delimits the future directionality of the enterprise by selecting and prioritizing the development of a limited set of products using the resources available. Therefore, the efficient and effective management of such a portfolio is critical to guarantee the ability of the organization to compete and survive in any possible future scenario. However, this is a challenging problem due to the characteristics of the development pipeline, namely, (1) the presence of uncertainty (internal and external), (2) the interdependency between projects, (3) the limited availability of resources, (4) the discrepancy between strategic and tactical/operational goals, (5) the dynamic propagation of the effects of lower level (tactical and operational) decisions in response to the resolution of uncertainties, (6) the overwhelming number of decision and state variables due to the length of the time horizon and the combinatorial nature of a portfolio (Blau, Pekny, Varma, & Bunch, 2004), and (7) the difficulty to terminate projects once they are begun (Buyukozkan & Feyzioglu, 2004). A wide variety of strategies capable of dealing with one or more of the features mentioned above have been proposed to help manage new product development portfolios (Cooper, Edgett, & Kleinschmidt, 1999; Hans, Herroelen, Leus, & Wullink, 2007). However, all

* Corresponding author. Tel.: +1 765 7144062.
E-mail address: zapata@purdue.edu (J.C. Zapata).

0098-1354/$ – see front matter
doi:10.1016/j.compchemeng.2007.03.024

of them assume that the decision making process can be decomposed into independent hierarchical levels, and therefore use models that do not take into consideration the dynamic propagation of the effects of lower level (tactical and operational) decisions when projects are analyzed as part of a portfolio. This assumption led to the development of decision support methodologies based on aggregated models with some type of static or semi-dynamic linkage that are valid when the process is close to deterministic, there is significant excess capacity at every stage of the process, or the pipeline does not contain multiple projects. However, in the highly uncertain, constrained, and dynamic environment of R&D the effectiveness of such methodologies is not so clear (Anderson & Joglekar, 2005). Decisions at any level in the pipeline may propagate in unpredictable ways, seriously affecting the performance of the portfolio in the long term. Such concerns are usually addressed through the use of sensitivity analysis and the examination of multiple scenarios. The problem with these techniques is that resource constraints, project interactions, and dynamics created by lower level decision making strategies may force the system to behave in ways that can not be captured in the static open loop models commonly used at the strategic level, creating a false perception of the capability of the pipeline. Thus, it is critical to determine if it is necessary to use a comprehensive approach to optimize the portfolio, in which the dynamics of all the different decision making levels are considered simultaneously. This work explores the implications of the decision making strategy at the tactical level on the selection and prioritization of new products using the pharmaceutical industry as case study. For this purpose a quantitative decision support framework capable of accommodating all of the characteristics of the pipeline with any degree of detail is proposed and implemented.

The rest of the paper is organized as follows. Section 2 reviews the literature that is relevant to the problem. Section 3 outlines the problem through simple examples. The proposed decision support framework is presented in Section 4. Section 5 presents a specific realization of the framework and describes the case study used to explore the implications of using different strategies to allocate resources in the selection and prioritization of projects in an R&D development pipeline in the context of a pharmaceutical company. Section 6 provides results and discussion for the case study. Finally, concluding remarks and perspectives are presented in Section 7.

2. Decision support strategies in NPD—strategic versus tactical

The development of decision support strategies and systems for managing new product portfolios dates back to the 1960s (Baker, 1975). As the field has evolved, it has become evident that decision support techniques must be able to provide insights to managers on how to minimize risk while optimizing an objective or a set of objectives (e.g. maximization of expected net present value, minimization of time to market, etc.) in the presence of constraints. Moreover, since then it has become clear that the simultaneous consideration of all candidate projects is the key aspect in managing a NPD pipeline. The complexity of the problem has led to the common use of decomposition based strategies, resulting in two completely independent bodies of decision support literature: strategic/tactical and tactical/operational (referred as strategic and operational for the remainder of this section). It is important to highlight that each of the two branches can be further subdivided according to the characteristics of the model used to support the decision making process. Though this distinction is not customarily made in the literature, it is essential to understand the assumptions behind each methodology. Fig. 1 shows the taxonomy of the main criteria to be considered when characterizing the level of detail of the model used in the decision support strategy for NPD portfolio management. The first sublevel reflects the fact that a project can be analyzed in isolation based on certain company standards (e.g. the net present value (NPV) of the project), or as part of the bigger picture where the performance is assessed at the portfolio level (e.g. NPV of the portfolio), including all the interactions between projects. The time dimension is found one level down in the classification. A dynamic model provides the specific state of the systems along each point of the time horizon (e.g. number of projects waiting for resource x at time t), while a static one uses average values to represent the system (e.g. average number of projects waiting for resource x at any time). Within static and dynamic classes it is possible to choose between deterministic and stochastic models. However, dynamic stochastic models have an additional partition: open loop versus closed loop. Open loop models only capture the response of the system to inputs from decision makers, while closed loop models also capture the response of the decision makers to the outcomes from the system.

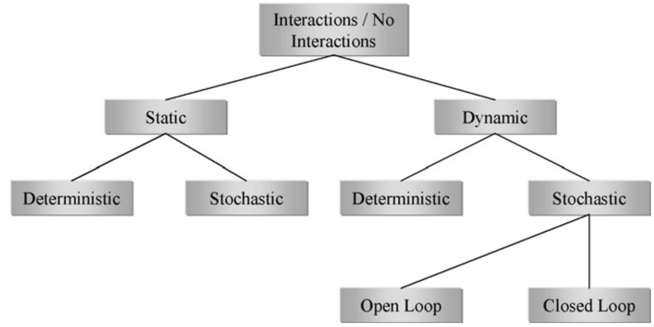

Fig. 1. Taxonomy of the level of detail of decision support strategies.

In the strategic decision support systems literature the different techniques available are shaped by the type of data used, namely, qualitative and quantitative. Strategies that are based on qualitative data and do not take into account project interactions are static. They have the main objective of translating the vagueness of adjectives used in classifications (e.g. excellent, poor, good, etc.) into structured forms that allow a quantitative comparison of the projects in the portfolio. The methodologies in this area can be grouped into scoring methods (Coldrick, Longhurst, Ivey, & Hannis, 2005; Cooper et al., 1999), analytical hierarchy approaches (Calantone, Di Benedetto, & Schmidt, 1999; Poh, Ang, & Bai, 2001) and fuzzy logic based approaches (Buyukozkan & Feyzioglu, 2004; Lin & Hsieh, 2004; Lin, Tan, & Hsieh, 2005). On the other hand, the methodologies that are