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PORTFOLIO MANAGEMENT

9.1 Introduction

A portfolio is a bundle of projects and/or programmes that are grouped together to facilitate their effective management to meet strategic business objectives. A project has a definable objective, consumes resources and operates under three main constraints: time, cost and quality. This is why the components of a project can be measured, ranked and prioritized (Kerzner, 2003). Portfolio management is the centralized management of one or more portfolios, which has the steps of identifying, prioritizing, authorizing, managing and controlling projects and programmes to achieve the strategic goals of the business. The goals of a business vary as widely as the ambitions, competence, vision and culture of each business.

Portfolio management is generally used in the financial services industry to define decisions about investment mix and policy, matching investments to objectives, balancing risk against performance and asset allocation for individuals and institutions. However, portfolio management has also become a field of interest for TM, since increasing globalization forces companies to invest in many R&D activities. Portfolio management is especially important for high-tech firms since the uncertainty faced by these companies can vary greatly. Therefore, strategies should be formed to avoid threats and exploit advantages through forming appropriate project portfolios (Mikkola, 2001).

Cooper et al. (1999) define portfolio management as a dynamic decision process that includes a constant updating and revising of a company's active new technology projects. The process is dynamic since new projects are continually evaluated, selected and prioritized, whereas ongoing projects may be speeded up, closed or reprioritized, and resources may be reallocated among projects. Managers are also constrained by the constantly changing opportunities, goals and strategic plans of the company and the interdependence of projects. Further, managers face the problem of high uncertainty since their decisions concern the products, services and processes that will be launched in the future. All these constraints explain why the portfolio should be closely monitored periodically to make go/kill decisions using a stage-gate process, as described in Chapter 12.

9.2 Where and why it is used

Portfolio management is extensively used in project-based organizations. From the perspective of manufacturing or technology-providing firms that have R&D projects, this tool can be used to manage three main TM activities:

- Acquisition.
- Learning.
- Selection.

Internal acquisition (Chapter 2) and selection (Chapter 7) capabilities require good management of portfolios for a number of reasons:

1 Resources could be spent on unrewarding projects, causing potentially superior ones to fail if there is no portfolio management.
2 All projects related to product, service, technology and process development involve a high risk, so portfolio management can help to manage the risks of these projects by choosing appropriate numbers of high- and low-risk projects.
3 The lack of a systematic procedure to choose between projects can lead to choices based on politics, opinion and emotion (Cooper et al., 2001).
4 Portfolio management helps to prevent a short-term focus, which would result in too many small projects.

Portfolio management helps selection decisions not only at the formation of the portfolio but also during the realization of the individual projects chosen within the portfolio. In other words, portfolio management facilitates the formation of criteria for go/kill decisions in order to prevent carrying out unsuccessful projects at stage-gates that may cause long lead times to market and poor quality products. Having sound selection criteria results in efficient acquisition activities as well, since these criteria bring discipline to acquisition activities.

Portfolio management is based on the notion of evaluating all projects at the same time. This is particularly important for sharing experiences across projects and diffusing project results across the company. Thus, the learning capability (Chapter 5) finds a solid ground to exercise its influence.

Besides the numerous advantages, there are a few drawbacks to portfolio management when determining the technologies to invest in or managing them, such as managing R&D projects. According to Ernst (2003), the main disadvantages are:

- Portfolios are based on subjective assessments made by respondents.
- They fail to incorporate competition due to a lack of necessary information.
- They do not allow for the analysis of dynamic technological developments.

9.3 Process

The major process in portfolio management is selecting projects that form the portfolio. It would be beneficial to adopt the framework developed for portfolio selection (Archer and Ghasemzadeh, 1999), in which there are three major steps:

1 Individual project analysis.
2 Optimal portfolio selection.
3 Portfolio adjustment.

The individual project analysis stage includes activities such as pre-screening and screening. Pre-screening considers whether the project being considered for the portfolio is in line with the strategic focus developed. A feasibility analysis and estimation of parameters are also essential for a project to pass this stage. Mandatory projects such as improvements to certain products are also decided at this stage. Activities at this stage of the process include strategy development and methodology selection, which are the tools to be used for portfolio selection. Screening is the elimination stage for projects or interrelated families

of projects that are not compatible with the expectations of the company, such as rate of return. The goal is to reduce the number of projects to be considered in the next stage.

The individual project analysis stage calculates parameters, such as project risk, NPV and ROI, with the estimation of uncertainties for each parameter. Ongoing projects can also be re-evaluated at this stage. The dominant models developed for project selection were from mathematical programming in the 1960s and 1970s. More recently, other methods are used to find the value of a project, such as financial models, probabilistic financial models, options pricing theory, strategic approaches, scoring models and checklists, analytical hierarchy approaches, behavioural approaches and bubble diagrams (Cooper et al., 1999). These groups of methods will be briefly mentioned below:

1 *Financial models* mainly depend on sorting and selecting the projects according to criteria such as NPV, internal rate of return (IRR) and payback methods (Cooper et al., 1999). The 'productivity index' is another measure that can be used to rank projects. It is simply calculated by dividing the difference between discounted and probability-weighted streams of cash flows from the project and R&D costs with R&D costs (Cooper and Edgett, 1997).
2 *Probabilistic financial models* include simulation methods such as Monte Carlo, which evaluates 'the outcome of alternative paths that have different payoffs with certain probabilities', and decision trees, which 'describe a problem as a series of decision nodes unfolding sequentially over time' (Canez and Garfias, 2006).
3 The Black-Scholes *options pricing theory*, where projects are treated as real options investments by facilitating decision making about an investment during different stages of the project (Whitney, 2007). The return on value allows management to make decisions about an investment during the different stages of the project, using multiple stages and considering a range of possible outcomes, including the financial consequence of failure.
4 *Strategic approaches* ensure that the projects selected are aligned with the overall business strategy. In the strategic buckets model, according to the strategy adopted, management decides on the resources to be allocated for each type of project, such as new product developments, process improvements, maintenance projects or fundamental research. The project portfolio is aligned with the strategy of the business with this top-down approach (Cooper and Edgett, 1997).
5 *Scoring models* are generally used to prioritize the projects in the portfolio selection process. In these models, evaluators rate each project according to certain criteria and then the scores are multiplied by their weights before summing up to reach the total score of the project (Cooper and Edgett, 1997).
6 *Analytical hierarchy approaches* determine the relative importance of each criterion by which projects will be evaluated and then compare each project alternative on these criteria to reach a ranking of alternatives.
7 *Behavioural approaches* are suitable for early stage-gates, since there is not much quantitative information available. Methods such as Delphi are used to reach a consensus between managers when choosing among projects (Cooper et al., 1999).
8 *Bubble diagrams* are used as graphical representations to visualize the balance of a portfolio. These maps typically illustrate the spread of portfolios on two-dimensional graphs, with axes showing risks versus profitability, marketplace fit versus product line coverage, financial return versus probability of success and so on. Figure 9.1 is an example of a bubble map that compares different projects in terms of their NPV and

probability of success. A third dimension is also added to the graph by representing the total revenue generated over the lifetime sales of the product with the size of the bubbles. The graph is a good representation of the risk–reward balance of the portfolio.

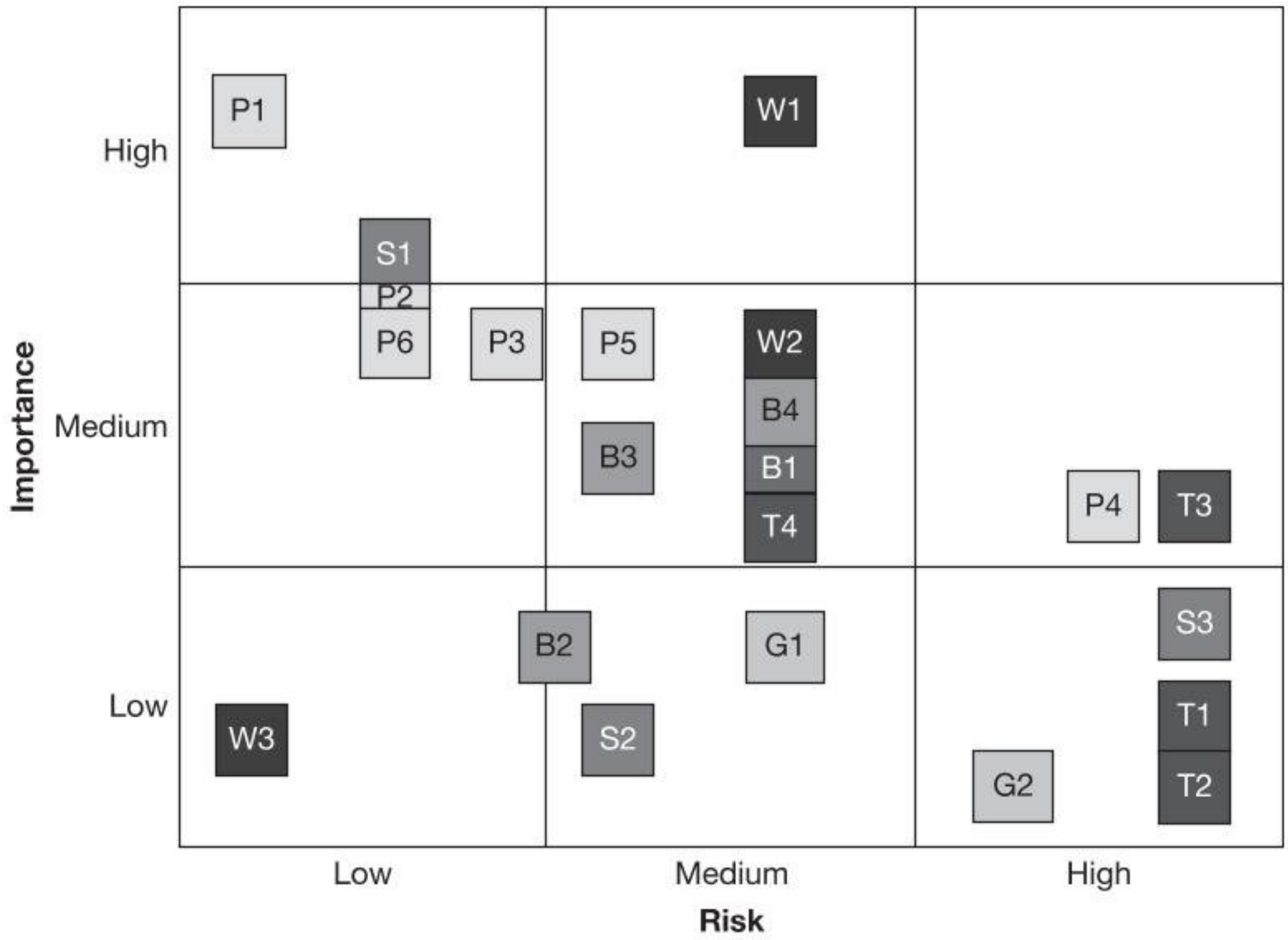

Figure 9.1 Technology assessment for *Scenario A*: 'Season in the Sun'

Code names of renewable energy technologies W1: On-shore wind energy; W2: Off-shore wind energy; W3: Small wind turbine; G1: Geothermal energy; G2: Incremental geothermal energy; P1: Crystal Si; P2: film of a-Si; P3: film of CIGS; P4: film of CdTe; P5: Organic dye; P6: Concentration photovoltaic; S1: ¼ Solar heating water boiler; S2: ¼ Solar heating air condition; S3: ¼ Solar heating energy; B1: Biomass energy; B2: Anaerobic ferment; B3: Biodiesel; B4: Bioethanol; T1: Wave energy; T2: Tide energy; T3: Ocean current energy; T4: Ocean Thermal Energy.

Source: Chen et al., 2009.

In optimal portfolio selection, three goals are used (Cooper and Edgett, 1997): maximizing the value of the portfolio, providing balance and supporting the strategy of the enterprise:

- Maximizing the commercial value of the portfolio involves allocating resources to the combination of projects so as to maximize its commercial value.
- A balanced portfolio involves balancing risk (high- and low-risk projects), types of projects (basic research and applied research), as well as target markets, among others.
- Linking the portfolio to the technology strategy of the business means making sure that the analysis takes the organization's technology strategy into account.

Although all the goals must be satisfied, the fit between the strategy of the enterprise and the R&D portfolio is particularly important for new product, service and process development (Cooper et al., 1997). Strategic planning for technology products was found to be the most important issue followed by organizational learning about technology (Scott, 2000). Therefore, firms need to define their R&D strategies and determine the areas in which they are planning to invest, such as new product development or maintenance projects. Then

resources should be allocated to each of the project types. Bubble diagrams can be used to ensure the balance of the portfolio, whereas the productivity index or expected commercial value can be used to serve the goal of maximizing the value of the portfolio.

At the final portfolio adjustment stage, some of the project parameters are recalculated when changes are made to substantially change the portfolio from the original at the optimal portfolio selection stage. At the adjustment stage, it is also important to consider the balance of the projects in terms of their risk, size and short-term versus long-term orientation (Archer and Ghasemzadeh, 1999).