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A THREE-POLAR CONSTRUCT

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ABSTRACT

There is no consensus on the construct project performance. This article examines how to suitably operationalise ‘project performance’ as it is viewed by practitioners. An alternative research approach, based on the repertory grid method, was used in combination with a survey to develop a three-polar framework of the construct project performance. The model stresses that the construct should be considered as multidimensional, including process, economic and indirect poles. It promotes a balance between financial and non-financial measures, between short- and long-term measures, between measures focusing on the past and measures directed at the firm’s future drivers. The model confirms and enriches the existing research on project performance.

INTRODUCTION

A combination of intense and global competition, short product life cycles, product diversity and fragmented markets has brought innovation management to the top of the competitive agenda in many firms [12,13,63,80,89]. In many organisations, product development has become a core competence [11]. Since the project is today's main organisational structure for developing new products, the definition of project performance [78] and the search for critical success determinants [17,51] has become extremely important.

Performance measurement may be interpreted as the acquisition and analysis of information on the attainment of objectives and plans, and on factors that may influence plan realisation [49]. Today, a wide variety of project performance measures are used [35]. There is still no consensus, however, on how to assess the performance of a product development project [38]. This stimulated us to study project performance in more depth in order to obtain a clear, well-defined model of the construct. This model may be used to guide both practitioners and researchers. It will be of particular value to studies focusing on success determinants.

Research on success determinants extends back at least to 1964 when the National Industrial Conference Board published an article entitled 'why new products fail' [14]. Booz, Allen and Hamilton 0[9] further increased the interest in mechanisms that stimulate success. Numerous academic scholars followed in their footsteps, trying to specify success determinants with various research methods. One method consisted of retrospectively analysing the characteristics of successful product development projects (e.g. [45,62,65,74]). In a similar way, the characteristics of past failures were identified [14,19]. Another approach used paired comparisons and discriminant analyses of successful and failed projects. These studies were mostly used in specific geographic

areas or business sectors [6]. Project SAPPHO by Roy Rothwell and his colleagues [72,73] as well as the Canadian New Prod studies [16,18] were exemplary. Many researchers replicated these studies in a variety of settings [32,58,59,64,83]. Nowadays, cross-regional comparisons occur more frequently [6,79].

Although this body of research has yielded many valuable insights, it also has some major disadvantages. It is doubtful whether projects can be classified as either very successful or absolutely unsuccessful. Moreover, the classification into successful or failed projects was made according to the chosen definition of project performance, which affected all further analysis. Another definition of project performance might result in another classification and, hence, in other determinants of success and failure. Because of the wide range of definitions throughout the literature, it is not surprising that several sets of success determinants were found [5,42] and that generalisation is difficult. Finally, the classification assumes that there is consensus between people on whether a particular project is successful or not and that these people use the same one-dimensional definition of project performance. In contrast, we see project performance as an ambiguous concept.

This objective of this article is to provide a new view on project performance. The first section discusses how project performance is assessed today. The second section describes the selection of an appropriate method and the third describes its application. The fourth section describes the results, which are placed within the management literature in the last section.

PROJECT PERFORMANCE

There is a growing need to measure and control the performance of R&D projects and organisations. If the old saying ‘what gets measured, gets managed’ is true, and we think it is, then it is obvious that one should avoid a situation where the measures are wrong or incomplete [76].

Project assessment in the management literature

The performance of a product development project has been operationalised by a variety of measures in the innovation measurement literature. Few instances of consensus have been found among the studies [38]. Griffin and Page identified 46 different measures in the 77 articles they examined. They detected, on average, three success measures per article [35]. Both objective (absolute figures or percentages) and subjective measures (opinion scales or yes/no questions) were applied [5,37].

Most studies considered only one aspect of project performance. Sometimes, more commercial and financial aspects were highlighted (see [61] for an overview). Other studies stressed non-financial measures, such as the process-related measures as budget and time performance [53,80,81] which are the most common measures in the project management literature to date [78].

Brown and Eisenhardt [11] subdivided the empirical innovation management literature into three main streams. Each stream focused on specific aspects of innovation and project performance, although there were some overlaps. The streams considered product development either as *rational plan* (e.g., [18,62,72,73,90]), as *communication web* (e.g., [2,3]) or as *disciplined problem solving* (e.g., [13,28,45]). Financial and commercial indicators were strongly highlighted in most of the rational stream studies, whereas lead-time and other typical process measures (e.g., speed, productivity) were used in the problem-solving literature. Finally, the communication web studies

considered various perceptual measures (team and management ratings). Griffin and Page [35] distinguished various clusters of research focus. These researchers found that 33% of the investigated articles concentrated on customer and financial measures, which perfectly fits within the rational plan stream, while 38% looked at product-focused measures that corresponded to operational and perceptual measures. The remainder highlighted strategic outcomes referring to programme and organisational performance, rather than to project performance.

In recent years, however, a few researchers in both the innovation and project management literature have stressed that the various approaches should be integrated: project performance should be considered as a multidimensional construct [7,31,39]. Therefore, some researchers started reviewing the literature to map the actual set of project performance measures [21,78]. Others also took into account the dimensions used by practitioners [35]. Afterwards, all researchers attempted to organise the set of success measures into a useful framework of more or less independent success aspects. The bundling of measures is done qualitatively and/or quantitatively. Some major studies are summarised in Table 1.

Insert Table 1 about here

These studies mainly started from the assumptions made by other researchers and did not deal with the available measures as such. Hence, it may be fruitful to examine ‘project performance’ in more depth by using an alternative method based on practitioners’ perceptions and not on what researchers think. This is particularly useful since differences in success measurement are found between academics and practitioners. The differences are related to the availability and accessibility of the data and to each group’s particular interests [35].

Project assessment in practice

In practice, there is no consensus on project performance. A wide variety of success measures are used since no single measure is sufficient for gauging the performance of every product development project [21,34]. In total, Griffin and Page [35] detected 34 performance measures. They found that companies that measure project performance consider on average about four separate measures. Two are measures of consumer-based success, one measures financial success and one measures technical performance. Most companies wish to use more than these four success measures, which would increase the total number of measures to 45. However, the difficulties and costs involved in assessing projects drive managers to use a simplistic approach [57,84]. We want to develop a global framework for project performance that reveals the measures of assessment that definitely should be taken into account.

We note that, in contrast to the literature, most practitioners consider multiple aspects of project performance. One reason may be that project performance measures are derived from project objectives, which are derived from the objectives and success measures at the organisational level. It is often deemed difficult to translate these aggregated organisational measures into project measures [33]. This is particularly true if the organisational measures are multidimensional and include the interests of various stakeholders [22,46].

AN APPROPRIATE DATA COLLECTION METHODOLOGY

Because our purpose was to map project performance in practice, the chosen level of analysis was the project, and the respondents were practitioners. Our concern consisted of finding a method that

produced valid and reliable data and that, at the same time, complemented the existing literature. The method was required to meet following minimum criteria.

Criteria

Firstly, the data should be captured from a heterogeneous group of practitioners having different functions, backgrounds and relationships with respect to product development projects. Indeed, different individuals may have quite different interests and beliefs [7,82]. They may notice different aspects of innovation or interpret aspects in a different way, which may result in other perceptions of project performance. Different departments, for example, have their own knowledge and system of meaning [24]. They have their own 'thought worlds', which may lead to different perceptions of project performance. *'An architect may consider success in terms of aesthetic appearance, an engineer in terms of technical competence, an accountant in terms of dollars spent under budget, a human resources manager in terms of employee satisfaction whereas executive officers rate their success in the stock market'* [31]. In addition, the perception of project performance may differ depending on whether the individual fulfils a central role or is more peripheral to the project. It may differ depending on the hierarchical level of the respondent. Moreover, as different individuals may have quite different thought worlds [48], Lipovetsky, Tishler, Dvir and Shanhar [57] simply stated that different people view project performance in different ways. Hence, various practitioners who have the same function in a particular company may also participate.

Secondly, the time perspective should be taken into account. The ratings of a particular success measure, and also the relative importance attached to different success, measures may change with time [42]. Given this time-dependency, we opted for a sample that included projects at different development stages. Hence, we hoped to find a variety of success measures, relevant at different stages of the product development process.

Thirdly, no assumptions on the project performance should be made in advance. We preferred to let the respondents fill in the construct. They should decide what the construct should look like, whether unidimensional or multidimensional, whether subjective or objective, whether financial or non-financial. It was thus necessary to map each respondent's individual view without influencing the respondent in any way. In other words, nothing should impose or even reveal the researcher's beliefs and perception during the data collection. Finally, besides such practical considerations as the time and costs to gather the data, the preferences of the investigator and the ethical acceptability to the respondent were taken into consideration (cf. [10]).

Cognitions and cognitive mapping

The different perceptions of project performance between individuals and the belief that product development decisions are taken in response to an individual's perceptions led to the decision to use *cognitive data*. Cognitions involve the mental models that people use to make sense of their world and to make decisions about what actions to take. These models incorporate the individual's unique past experiences and reveal how information is selected, configured, reconstructed and used differently by different people [8]. In the area of innovation management, cognitions are seen as the specific belief systems of individuals who draw upon some subset of available knowledge in formulating expectations and in making choices about innovation. Knowledge is thus seen as the pool of information and understanding in the organisation that provides the potential to innovate [82].

A *cognitive map* is an individual's internal representation of the concepts and the relations between concepts used to understand the environment. A cognitive mapping methodology is a method used to access the cognitive maps inside someone's head and to portray these externally in a layout [82].

With respect to our study, cognitive mapping methodologies may allow us to map project performance, as considered by various individuals.

The general approach for cognitive mapping consists of extracting statements from individuals on key concepts and relations in particular problem areas. Different methods exist to elicit and analyse these statements. Huff [41] places the methods along a continuum from those that describe the manifest content of cognitions to those that describe the underlying structures and processes. The *repertory grid method* [27,30,48,52,71] is one example of the many methods described. This method was selected because it allows for the exposure of both the content and structure of an individual's cognitive system and because it takes into account the criteria discussed above.

The repertory grid method

The repertory grid method was developed to operationalise the personal construct theory. During the 1930s, the psychologist George Kelly developed the personal construct theory as a basis for counselling US university students [25]. Kelly wanted to help people facing future situations by making them analyse their world and interpersonal relationships. He believed that anyone was able to generate a unique repertoire of mental constructs—their personal constructs through which they ordered their thoughts and experiences—and make sense of what is happening to them at any particular time [68,77]. The generated constructs thus depended on both the situation and the person generating them. A fundamental assumption of the theory was that an individual acted as a scientist who actively explored the world, developed knowledge and whose vision strongly determined his or her actions. At that time, the theory complemented the range of available psychological methods that were geared towards large-scale analyses. More details can be found in Kelly's work [48].

To operationalise the theory, Kelly required a method that would reliably elicit the interviewee's cognitive structure without introducing bias from the interviewer's frame of reference. The method he found was called the repertory grid method. The method elicits the similarities and differences that constitute the bipolar dimensions (personal constructs) an interviewee uses to differentiate between elements. It allows the collection and analysis of both qualitative and quantitative data. It should be seen as a general data collection methodology that includes a set of semi-structured interview techniques using a common structure, rather than as one single technique ([71], p. 301). Kelly also described a number of variations on using the method. Since the 1960s, many modifications and extensions have been made [25]. Fransella and Bannister wrote a manual for researchers interested in using the repertory grid method [30].

Although the method originated from clinical psychology [77] and although a great majority of applications focused on clinical matters up until the mid-1960s [25], it has been applied in a variety of domains since then. Latta and Swigger, for example, modelled knowledge to develop intelligent front-end interfaces for information systems [52]. Hunter used the method to identify the qualities and characteristics of excellent system analysts to improve personnel selection [43]. Further, the method has been used in problem solving [27], performance appraisal [68,77], competitive positioning analysis and strategic decision-making [69,70]. Easterby-Smith et al. [25] mention its use in training and development, market research and consumer relations. Despite the wide range of applications, the method seems to be new in the area of innovation management, although Swan suggested its usefulness in this area [82].

METHODOLOGY

The key data collection decisions when designing our repertory grid study were 1) the selection of elements, 2) the generation of dimensions by comparing triads of elements, and 3) the perception of the elements in terms of the dimensions.

Selection of the elements

In this study, product development projects were the elements. The projects were required to be well defined, recent and self-contained. This ensured that people knew from its name which project was meant when its name was mentioned and were able to reconstruct the project's history easily. Besides finalised projects, projects cancelled partway and on-going projects ready for pre-production were included. Another, often restricting, requirement of the projects was that the interviewees should be familiar with at least five of the projects under consideration so that a sufficient number of triads could be composed (see below).

The first contact person in each participating company selected approximately six projects. The companies were selected from a variety of business sectors to guarantee a wide range of perspectives. The companies were selected randomly. From the 14 selected companies, one refused to participate. Five companies were interested but did not fulfil the requirements concerning either the projects or the interviewees. Finally, eight companies and 49 projects were adopted in the sample. The business sectors included the design and manufacturing of a) adhesives, b) aluminium products, c) measuring equipment, d) electronic components, e) railroad vehicles, f) steel and fibre products, g) suit cases and h) products for telecommunication and broadcasting. All companies were of a sufficient size and innovative capacity to assure the required amount of projects and interviewees. None of the companies had undertaken actions or organised meetings concerning critical success determinants of product development in the recent past. This was avoided because

the repertory grid method requires the interviewees to be open-minded. From a logistic perspective, the sampled region was limited to Flanders, Belgium.

The generation of the dimensions

The 53 interviewees that were recommended by the first contact person in each company elicited various dimensions of product development projects. Interviewees with different functions, background or interest were included in the sample (see Table 2a). The interviewees either had a steering function or were at the core or the periphery of the selected product development projects. Note that someone at the core of one project might be at the periphery of another project.

Insert Table 2a about here

Insert Table 2b about here

The dimensions were elicited by using the minimum context format of the repertory grid method [30,71]. After verifying whether the interviewee knew the projects provided by the first contact person sufficiently, only the well-known projects were retained. The interviewee was then presented with a triad of project names out of the remaining group and was asked to compare the projects. By eliciting similarities and differences, the dimensions an interviewee used to differentiate between product development projects were elicited. To facilitate the interviews, each project name was written down on a coloured card. The cards and the ability to move them improved the transparency and helped focus the interviewee's thoughts. Moreover, they made the interview more pleasant.

The comparison of a particular triad continued until the interviewee felt satisfied and no new dimensions were generated. Another triad of cards was then selected and the comparison exercise

started again. The sequence of selected triads was random. By comparing the first triads, the researcher left the issue of similarities and differences open-ended. This allows for the spontaneous generation of any similarities and differences that came into the interviewee's mind and seemed relevant to him or her. After a few triads, a first saturation effect appeared. Then, the researcher provided the interviewee with some clues to inspire him again. In this manner, more information was obtained. The clues were well-chosen, general concepts that revealed as minimally as possible the researcher's cognitive structure. They were similar for all triads and interviewees, but were interpreted differently depending on the interviewee and his or her cognitive structure. The clues were 'idea, elaboration of the idea, competence, organisational approach, responsibilities, interactions, impact, involvement, people, problems, suggestions and success.' The total interview took 90 minutes to complete, on average, which, of itself, was an index of the interest generated by the study.

The generation of dimensions should not be stopped before the saturation effect occurs because it might prevent the identification of some dimensions. Reger ([71], p. 301) found that, depending on the specific domain and research design, the saturation effect generally occurs after seven to ten triads. This explains why one of our requirements was that the interviewees were able to compare at least five of the projects under consideration. A minimum of 10 triads (5!/2!3! = 10) could then be composed, which exceeded the saturation amount mentioned by Reger. We discovered that in our study an interviewee commented on six to seven triads on average before the saturation effect appeared.

The perception of the elements in terms of the dimensions

The repertory grid study also provided some initial quantitative data. All of the 53 interviewees were asked to rate their own generated dimensions for all the product development projects that they

had compared. Therefore, during the interview, the researcher distilled the main dimensions generated by the interviewee and wrote them down in the first column of a rating grid. We note that the final dimension to be evaluated was kept the same for each interviewee: it was the *'overall success'*. The projects well known by the interviewee were noted in the first row. At the end of the interview, the interviewee completed the other cells of the matrix by evaluating each project per dimension on two scales. The first of the scales represented the presence of the dimension in a particular project; the second scale represented the perceived importance of the dimension to project performance (without specifying what was meant by project performance). The type of scale, which dominates in existing applications of rating grids [71] was selected because of its sensitivity to small differences in perception.

The ratings provided extra information and allowed a validity check of the qualitative data. They allowed immediate verification of whether the dimensions written down captured a person's precise meaning (cf. [68]). Moreover, they helped to identify similar dimensions; several dimensions were initially deemed rather similar, but, by comparing the ratings of the dimensions in the different projects, it became obvious whether two dimensions really conveyed a distinct meaning or not. The score on 'overall success' enabled an examination of which dimensions or constructs were the most central to a person's view of project performance (see below). More details on the repertory grid study are described in [85].

An additional survey

On completion of the repertory grid analysis, a detailed questionnaire was built to obtain more quantitative data since the repertory grid method only provided information on the self-supplied dimensions of an interviewee. Each questionnaire represented an evaluation form of a product development project. It contained all the dimensions elicited during the repertory grid study that

remained after a purification process. The purification process eliminated those dimensions that only differed in formulation. Three researchers independently analysed the interview notes by content analysis and studied the quantitative repertory grid data. The remaining list of dimensions was adopted in the questionnaire. It included both success measures and potential success determinants that were measured in a similar manner as during the repertory grid study. In addition, some background information on both respondent and company, were gathered. Three colleagues and four people from different companies and business sectors completed and commented on the questionnaire individually. Afterwards, their answers and comments were discussed and the questionnaire was adapted.

The random sample included 25 of the 126 Belgian innovative companies that were contacted. The participating companies represented a variety of business sectors including the design and manufacturing of food products, textiles, machinery, chemical and photographic material, micro-electronics, luggage and handbags, fabricated metal products, electrical machinery and apparatus, television and communication equipment and apparatus, motor vehicles, railway locomotives and rolling stock, lighting materials and components, precision instruments, cargo handling equipment and plastic products. The sample included 103 questionnaires corresponding to 61 product development projects. The 61 projects consisted of 35 finalised projects and 26 projects that were on-going or cancelled partway. Sixty per cent of the projects lasted a maximum of two years and 10 per cent took longer than three years. Ten per cent of the projects were categorised as fundamental research. The median respondent had 10 years of work experience, had been working approximately eight years for the company and had six subordinates. The respondents represented various disciplines: 32 per cent had been working in R&D for the last four years and 28 per cent in production or quality. Other functions that were represented in the sample were marketing,

purchase, quality, sales, planning and general management. Fifty-five per cent of the respondents had acquired a university degree.

THE RESULTS

The major empirical findings were organised into four areas. They concerned: 1) the identification of success measures; 2) the search for underlying success aspects; 3) the construction of a three-polar model, and finally 4) the comparison of the results with previous research on innovation.

Identification of success measures

The analysis of the content and structure of the interview notes provided by the repertory grid study delivered a range of dimensions. These dimensions were classified as success measures or potential success determinants by three independent researchers. The easiest cases were those where the interviewee explicitly referred to a dimension as a measure of success. However, the success measures had often to be derived implicitly. Here, a critical issue was to distinguish between success measures and success determinants: a success measure represents an outcome, whereas a success determinant is a cause. The rating of the last dimension on the rating grid, namely the overall success, provided another opportunity to discover the dimensions an interviewee associated with the project performance (cf. [68]); similar evaluation patterns between a particular dimension and the global success along the various projects provided hints. In total, 25 project performance measures were identified.

Many differences in the perception of project performance were observed between the interviewees. These differences not only occurred between companies and between functional departments, but

also appeared between people having different relationships to the project (central or peripheral, steering or executing) or having different personality characteristics. Depending on the cognitive structure, we found that some people were thinking more in terms of time performance or pointed to the degree to which the objectives concerning budget and technical specifications were met. Others stressed the development of new and useful capabilities or they referred to the contribution of the project to the firm's future or to the prestige of those involved in the project. Despite the many differences in perception of project performance, most interviewees mentioned customer acceptance. Meeting customer expectations was a central issue in each interview and hence, as Reger stated, was deemed important ([70], p. 71). This finding is in line with the literature proclaiming the global importance of customer satisfaction [42,57].

Another interesting observation was that the interviewees pointed to strong differences between financial success measures and other performance indicators such as throughput times and cost efficiency. The latter performance indicators were mentioned as being important 'guideposts' in learning about the product development process. In other words, they gave insight into and helped to continuously improve the development process, whereas the financial and commercial indicators do so to a lesser extent. In an era where the capability to quickly learn from failure and experimentation is probably one of the hallmark characteristics of successful innovators, a monolithic economic performance approach is dangerous as it tends to focus on single-loop learning rather than double-loop learning [1]. Furthermore, the interviewees pointed to the fact that financial or commercial indicators were less reliable when, in an anticipatory or proactive mode, large amounts of market development and customer education were required. Important time lags might be involved before a product's financial or commercial performance could be assessed. In other words, the respondents underlined not only the multidimensionality of project performance but also the time and project dependency of the relevance of different success aspects.

The underlying success aspects of multidimensional project performance

The 25 success measures identified during the repertory grid study were subsequently rated in our survey for their presence. After the elimination of outliers in three iterations, we performed a principal component analysis to bundle the measures into a few major groups if possible. Measures causing instability, low Cronbach alphas or eigenvalues below value 1.0 were not adopted. The analysis revealed a seven-dimensional model of project performance (see Table 3). We labelled the success aspects as respect for time (S1), respect for budget and technical specifications (S2), knowledge creation and transfer (S3), contribution to the prestige of the people involved in the project (S4), respect for the project's innovativeness (S5), contribution to the company's business success (S6) and financial and commercial success (S7). We briefly describe each of these success aspects.

Insert Table 3 about here

Respect for time bundles measures that refer to meeting timing and planning goals. This yardstick for process performance has been broadly discussed in the literature to date [12,81,87]. ***Respect for budget and technical specifications*** is another yardstick for process performance. Respect for budget simply indicates whether the project was completed within the specified budget. The combination of increased competition, the pressure on margins and the shorter product life cycles in some sectors have made respect for time and budget critical competitive aspects in particular businesses [78]. Respect for technical specifications refers to the challenge to meet the initial technical specifications. The specifications are usually highly specific and must be determined for each project separately [39]. They can be determined on the basis of factors such as the external

customer and market expectations [78], or the internal expectations to ensure manufacturability [31] or to meet strategic objectives.

Knowledge creation and transfer. A project may perceived to be successful because of the increase of expertise and experience [39]. Knowledge creation is situated on two levels; it includes both single-loop and double-loop learning [1]. It contributes to personal and organisational growth; the absorptive capacity increases [15]. Beside knowledge creation, knowledge transfer is a hallmark for success [39]. Knowledge transfer concerns the linkages between different product lines (inter-product-line linkages) as well as the linkages between past and present projects (evolutionary linkages), including product redesigns or replacement projects [60,63,88]. It allows increases in the competitiveness of existing products or extensions of knowledge into a new market segment or product line while achieving economies of scope [75]. To compete effectively, one should build deliberate strategies and processes to share knowledge efficiently across a portfolio of projects [63].

Prestige. The extent to which a project contributes to the prestige of the people involved in the project was also perceived to be an important success aspect. A development project can be seen as an instrument to build social recognition and an instrument of self-actualisation [39]. Building reputation appears to be an important motivator. It can lead to a better pace of progress or incite ambitions for more challenging and successful projects. Hence, the cyclic spiral of efficacy–performance starts: performance affects self-efficacy that in turn affects performance, and so on [55]. Prestige can be marked by tangible assets such as publications, quotations, prizes and other distinctions, but it is also found in less tangible aspects.

Respect for innovativeness addresses the achievement of the expected innovativeness and originality in a project. A project may be innovative to the company or to the market. Wheelwright

and Clark [89] underlined the importance to strive for a mix between breakthrough, platform and derivative products. The derivative products should ensure the firm's stability and try to maximise the contribution of old cash cows and existing knowledge. In contrast, the very innovative projects should create internal opportunities for knowledge accumulation and external opportunities to gain competitive advantage. They are important in searching for new cash cows. Although striving for a balanced mix is related to the multi-project level of management and should therefore be measured for its successful implementation at that level, an important criterion at the project level is the extent to which the expected innovativeness is realised in a particular project. Realising the expected innovativeness in the various projects finally ends in realising the proposed product portfolio.

Contribution to business success refers to the contribution of a project to the sustainable long-term strength of the organisation [78]. It concerns the project's contribution to prepare the organisation for the future. For example, does the project prepare the company to adapt quickly and meet additional challenges, such as unexpected moves of competitors, markets or technologies? It reveals the degree to which a project affects the firm's growth and helps in building a positive and innovative company image. An adequate image may affect the future because it can facilitate the allocation of subsidies for subsequent projects [39] and influence the customer basis and relationships. Contribution to business success is the longest-term aspect in the multidimensional construct project performance.

Financial and commercial success addresses the direct impact of a project on the organisation's financial status. It gives an answer to questions such as: '*does the project provide the expected sales, profits or cash flows? Is the project a commercial success?*' This success aspect is used quite often in the innovation management literature [11,61].

A qualitative comparison

In summary, our study reveals that project performance is a multidimensional construct. The various aspects that comprise the construct can be distinguished by various criteria. They concern the type of measure, the focus, the time orientation and the time frame of relevance. The comparison is made qualitatively on the basis of the repertory grid interviews combined with a study of the management literature.

Among the seven success aspects, several ***types of indicators*** were identified. They include process, economic and indirect indicators. Respect for time, budget and technical specifications are process indicators, whereas financial/commercial success is an economic indicator. Contribution to business success, prestige, respect for innovativeness and knowledge creation and transfer are rather indirect effects. They refer to the project's contribution to organisational and personal 'growth'.

All success aspects address the project ***level*** and moreover, are implicitly linked with higher organisational levels since they are derived from inter-project and organisational measures. However, two success aspects not only implicitly but also explicitly refer to these higher organisational levels. Firstly, knowledge transfer explicitly refers to an inter-project or programme level [39]. Secondly, contribution to business success explicitly points to the organisational level; an evaluation at the organisational level is necessary to demonstrate whether global image, growth and opportunities are positively affected.

Furthermore, the ***focus*** of the success aspects differs (cf. [46]). Knowledge creation and transfer is internally oriented. Respect for time and technical specifications are mainly internally oriented, although they also have an external aspect because they may be measured in terms of the external market and competitor references. In contrast, business success has a mainly external orientation.

Even so, financial and commercial success must be realised mainly externally, although profit achievement is also internally oriented. Finally, prestige and respect for innovativeness may be measured both internally in the company and externally on the market.

Time orientation is another criterion (cf. [46]). Some success aspects seem to refer to past performance, whereas others address the drivers for future performance. Respect for time, innovativeness, budget and technical specifications as well as financial and commercial success are mainly focused on the past. In contrast, the contribution to business success is more future-oriented. Even so, knowledge creation and transfer reflect the developed competencies and spin-offs, which may be drivers for future performance. Prestige combines both: it reflects past performance and, at the same time, it is favourable for the future since it may start the cyclic spiral of efficacy–performance [55].

A final criterion is the ***project life cycle relevance*** (cf. [46]). The relative importance of success aspects may differ as the project proceeds [42]. During project execution and immediately after project completion, time and budget performance are found to be the most important. Knowledge creation and respect for innovativeness are probably other important points of attention at that time. Once the project is completed, the relevance of time and budget performance declines [4] and financial/commercial success gains importance. Quite some time after the project's market introduction, the contribution to business success can be assessed appropriately. At that time, managers start to see the impact of a specific project on the future of their organisation. A few success aspects remain important along the various project stages. They include customer satisfaction—which, in our case, is reflected in several measures (see below)— and the achievement of the technical specifications [42]. We propose also that prestige and knowledge transfer—as long as the knowledge does not become obsolete—remain relevant.

In summary, our seven-dimensional model of project performance includes short-term and long-term measures, financial and non-financial measures, internally and externally oriented measures, measures focusing on the past and others oriented to the firm's future drivers.

Time-dependence of the model

To examine whether the model remains valid throughout project stages, we classified the projects into two categories—the first category included the projects that were already completed and the second the projects that were under way at the time of the survey. It was interesting to see that the principal component analyses conducted on the two categories separately delivered the same model as for the entire set of projects. Only respect for time was subdivided in two subgroups for the projects that were still ongoing. One subgroup referred to the actual respect for time, as it was perceived at the moment of filling in the questionnaire. The other subgroup included the expected respect for time at the end of the project. The split was only because of the different meaning of the measures and did not harm the model. Hence, the model appears to remain valid throughout development stages. There seems to be no need for different information bases at different project stages. Presumably, only the relative importance of the various success aspects differs over time.

A three-polar model

To find some evidence for the qualitative distinction between process, economic and indirect indicators, we conducted hierarchical cluster analysis using Euclidian distances. Cluster analysis allows identifying groups of similar success aspects. Hereby, the success aspects were constructed as the standardised mean of the success measures reported in Table 3. The results were the following.

Independent of the method used (*'furthest neighbour', 'nearest neighbours' and 'average link between groups')*, the three clusters identified correspond to the proposed grouping in process, economic and indirect aspects. In other words, the seven-dimensional model can be summarised in a three-polar model including process, economic and indirect poles. The process pole contains respect for time, budget and technical specifications. The economic pole refers to financial and commercial success. The indirect pole includes knowledge creation and transfer, respect for the innovativeness, prestige and contribution to business success.

Insert Figure 1 about here

Two success measures were not included in the principal component analysis reported in Table 3. The first is the degree to which the customer specifications are met, and the second is the degree to which the project contributes to internal strategy. The reason these measures were not included is that they both loaded on several factors, whereas it was our primary purpose to distinguish separate underlying success aspects. However, the finding that these measures loaded on several factors is quite interesting in its own right. It may hint at the importance of considering the internal strategy (see also [34]) and external customer as points of reference, against which various success aspects should be evaluated. Ideally, the two points of reference are inter-related. In other words, strategy should take the customer into account.

Position within the management literature

In recent years, a few researchers have stressed that project performance is multidimensional. Table 4 illustrates how the overarching success aspects of the different studies compare with our findings.

A table of comparison

The second row of Table 4 identifies the success aspects of our project performance model. The other rows represent some other models available in the innovation or project management literature. The grey blocks in these rows reveal overlaps between the success aspects of a particular study with our success aspects. We see that some success aspects only partly refer to our success aspects whereas others tend to cover several of our success aspects. The numbering of success aspects is retained from the respective studies.

Insert Table 4 about here

Cooper and Kleinschmidt [16] identified three perspectives for investigating project performance: a1) financial performance, a2) market impact and a3) opportunity window. As Table 7 demonstrates, the scope of their view on project performance was rather limited. Their first couple of measures (a1, a2) mainly correspond with our commercial and financial success (s7). Their third perspective, the opportunity window (a3), portrays the degree to which a project opens up new opportunities for new categories of products and new market areas. This perspective can be found partly in our contribution to business success (s6) and also in knowledge transfer (s3), which reflects the spin-offs that a project contributes. The perspective has a strategic flavour. We highlight that the strategy is considered a point of reference in our model, reflected in various success aspects (e.g., in s3 and s6).

Hauschildt [39] compared how 30 empirical investigations measured the success or failure of innovation. He found three categories of measurement attributes: b1) direct and indirect technical effects, b2) direct and indirect economic effects, and b3) other effects. Direct technical effects (b1) can be registered in the form of highly specific measurements, which must be determined for each innovation project separately. Indirect technical effects (b1) include learning effects, an increase of

expertise and experience, transfer effects or spin-offs. They may occur even when an innovation turns out to be a technical failure. The direct technical effects obviously refer to respect for technical specifications in our model (s2), whereas the indirect technical effects are related to the knowledge creation and transfer (s3). We note that knowledge creation and transfer in our study has a broader scope. It includes learning effects for technical but also for non-technical aspects (e.g. organisational items). Hauschildt's direct economic effects (b2) concentrate on sales, profits and costs. These effects are found in our commercial and financial success aspect (s7) and in respect for the budget (s2). Hauschildt emphasised that, in addition to sales growth and cost reduction, the successful creation of an innovative image is important, which is covered by our contribution to business success (s6). The indirect economic effects (b2) consist of the effects a project has on the firm's competitive environment. Although similar measures were not explicitly taken up in our study, they easily fit within the contribution to the business success (s6); e.g., a sales reduction for competitors can be translated to a larger market share for the company, which is one aspect of our contribution to business success. Finally, Hauschildt highlighted 'other effects' (b3) belonging to the individual or organisational sphere. The individually related effects are clearly linked to our prestige (s4). However, the organisationally related effects such as sociological and social effects are more difficult to relate to our scheme. These effects only fit in our model if they are part of the project objectives and so are reflected indirectly, for example, in the technical specifications (s2).

From a review of the literature, ***Freeman and Baele*** [31] identified seven main criteria used for measuring project performance in the 14 studies that they considered. The first criterion is technical performance (c1), which evaluates the extent to which the technical requirements specified at the project start are achieved. The second is efficiency of project execution (c2), which refers to the degree to which time and budget targets are met. These two criteria fit perfectly with respect for time (s1) and budget and technical specifications (s2) in our model. Furthermore, project

termination (c5) defined as the completeness of the termination, the absence of post-project problems and the quality of post-audit analysis also appear to refer to our respect for technical specifications (s2). Uncompleted, low quality designs usually fail to meet technical specifications if the project is evaluated before being adopted. Technical innovativeness (c6) is defined as success in identifying technical problems during the project and solving them. It indicates how well the technical specifications are met (s2). It may also imply some knowledge creation (s3) and may reveal whether technical innovativeness (s5) is realised. Personal growth (c4), defined as satisfaction of the project team in terms of interest, challenge and professional development, covers prestige (s4) and to a lesser extent knowledge creation (s3). Depending on whether the authors define a project team as all the people involved or only as the group of designers involved (which is not clear from the article), prestige is covered entirely or only partly. The heterogeneous criterion 'manufacturability and commercial performance' (c7) refers to respect for technical specifications (s3) at the moment of introducing the product in production and to financial/commercial success (s7). Finally, the definition of the criterion 'managerial and organisational effects' (c3) is not clear to us. It is defined as a measure of client and user satisfaction, incorporating the degree to which the project was carried out without disturbing corporate culture or values. It probably refers to the degree of innovativeness, which we consider more as a task type than as a success measure.

In their interim report, ***Griffin and Page*** [35] grouped 75 success measures into five categories: d1) customer-acceptance, d2) financial, d3) firm-based, d4) programme and d5) product-level measures. Their financial measures (d2) correspond with our financial success aspect (s7). Customer-acceptance measures (d1) include measures such as the degree to which revenue and sales volume are met and hence mainly correspond with our commercial success (s7). We note that our study does not argue for a separate success aspect concerning customer acceptance but favours considering the customer as a point of reference, against which various success aspects are

evaluated. Griffin and Page also distinguished firm-based (d3) and programme measures (d4). These measures are—except for three measures—not situated at the project level and therefore, do not appear in Table 5. They refer to the organisational and programme level and hence are not included in our study. The three exceptions are the extents to which the project: can be line-extended, hits a window of opportunity and strategically fits with the business. They are captured in our knowledge transfer (s3) and contribution to business success (s6). In our study, strategy is a point of reference, reflected in several success aspects. Finally, the product-level measures (d5) are a rather heterogeneous set of measures that cover several of our success aspects, as shown by Table 7. The measures mainly refer to respect for time (s1), budget and technical specifications (s2), prestige (s4) and contribution to business success (s6).

Shenhar, Levy and Dvir [78] collected survey data from 127 respondents in a variety of industries on 13 measures of success and on an additional overall success measure. The researchers distinguished four separate factors by factor analysis. They called them customer satisfaction (e1), budget and schedule (e2) and the impact of the project on the performing organisation, which included two success aspects: the first reflected the immediate and commercial success of the project (e3), and the second the potential created by the project for the future (e4). Customer satisfaction (e1) involved fulfilling customer needs, solving a major operational problem, actual usage by the customer and customer satisfaction. This measure refers to our point of reference concerning customer expectations and is reflected in several of our success aspects such as respect for technical specifications (s2) and commercial success (s7). The second factor (e2) concerns the extent to which time and budget goals are met. It refers to our respect for time (s1) and budget (s2). The third factor (e3) covers our commercial success (s7) whereas the fourth factor (e4) is included in our contribution to business success (s6) and knowledge transfer (s3). The fourth factor indicates whether the project opens a new market or a new line of products, or whether new technology is

developed. It has a strategic flavour and can be compared with the opportunity window (a3) of Cooper and Kleinschmidt [16].

Finally, we find it useful to look at the balanced scorecard model introduced in the early 1990s by ***Kaplan and Norton*** [46,47]. Although it was introduced in operational contexts including service organisations, we now apply it in a product development environment (cf. [22]). Although its use was recommended at the business unit and departmental level, we translate it to the project level. The scorecard includes four major perspectives, namely financial (f1), customer (f2), internal business (f3) and innovation and learning (f4) perspectives. These perspectives give answers to the following questions: 'How does the organisation look to its shareholders?', 'How do the customers see it?', 'What should the organisation excel at?', and 'Can it continue to improve and create value?'. These quite global perspectives deliver a framework that covers most of our success aspects. The first perspective (f1) is related to our financial success (s7). The second perspective (f2) relates to the customer expectations point of reference and matches various success aspects. The third perspective (f3) includes the process measures (s1, s2) and respect for innovativeness (s5). The last perspective (f4) is likely to cover knowledge creation and transfer (s3) and contribution to business success (s6).

DISCUSSION

Our study and the resulting three-polar model of project performance confirms and enriches the existing literature by its approach, by the clarity of the results, and by the integration and extension of insights reported in the literature.

Integrating and extending the insights from the literature

Our model integrates various success aspects that are mentioned throughout the literature. It delivers a global framework on project performance that covers the insights from various studies and shows how to extend them to obtain a more complete view of project performance. For example, the results of Cooper and Kleinschmidt [16] are mainly reflected in our economic pole and partly in the indirect pole. Hence, a more complete view on project performance can be obtained by considering process-related success aspects and indirect success aspects such as prestige, knowledge creation and respect for innovativeness.

When we compared our model with others in the literature, we found that past research was mainly focused on the process and economic success aspects, whereas indirect success aspects were often neglected. However, these indirect aspects are really important in today's world. The learning perspective, for example, is important for companies in which innovation and continuous improvement are critical [11]. Nevertheless, only the balanced score card and Hauschildt's model take this perspective into account. Only Hauschildt explicitly considers measures concerning both the development and the transfer of knowledge. As well as knowledge creation and transfer, we stress that respect for innovativeness is important, because it reflects the degree to which the project helps to realise the product portfolio within a strategy of renewal and diversification. A final success aspect that should not be neglected concerns personnel. People are the heart of product development. High prestige is beneficial for both people and company.

Although the study of Griffin and Page is one of the most insightful and rigorous studies concerning success, our study advises that the product-level measures be broken up, thereby reducing the heterogeneity of this success aspect. Furthermore, our model enriches the scorecard [46] translated to the project level. It suggests, for example, that the internal business perspective and the innovation and learning perspective be refined. Furthermore, it advises the consideration of such

personnel-oriented measures as prestige. Hence, our study delivers a refined view on project performance.

Information from published research suggests that our financial and commercial success aspect should be broken up into a pure financial aspect and a pure commercial aspect. Another suggestion concerns the splitting up of the second process aspect into respect for the budget on the one hand and respect for technical specifications on the other hand (see also the lower Cronbach alpha). Nevertheless, these refinements appear to leave the global three-polar model unchanged.

It should be noted that project performance is one aspect of a company's overall performance. Much of what has been written on performance at the organisational level has been found relevant to project assessment [42]. This is particularly true for our study on project performance. We consider, for example, the distinction between financial versus broader criteria such as innovativeness and market standing at the organisational level [86]. As well, there are the changes that success measurement at the organisational level have undergone because of new strategies and competitive realities. Non-financial indicators are acquiring, more and more, the same status as financial measures [26,29]. Moreover, Kaplan and Norton showed that there should be a balance between financial and non-financial measures, between internal and external measures, between measures of past performance and measures referring to the firm's future drivers [46,47]. Our study seems to underscore that the striving for a balanced and integrated performance is adequate at the project level as well.

A well-defined and refined multidimensional model

Our study tried to map project performance unambiguously. It clearly defines the success aspects and mentions the underlying dimensions (Table 3), which has not always been the case in the

literature [31]. When researchers clearly mention which success aspects they are considering or when they use the same performance model in studies on success determinants, it is easier to compare findings and make conclusions. Furthermore, our results reveal that rating a project on one global, undefined success measure is unreliable. Indeed, when people are asked to rate the overall appraisal of a project, one may wonder what, in fact, has been measured: the individuals take only those aspects of the multidimensional project performance into account that represent their specific views and interests.

In sharp contrast to a large body of literature, customer-related measures are not considered a separate success aspect. We prefer the presence of the customer in the evaluation of most success aspects by defining the customer as a point of reference. This, at the same time, avoids the confusion that often occurs in the literature. In previous research, customer-related measures cover a heterogeneous set of success aspects; they cover technical [78], commercial or other success measures [35].

The research method

Hauschildt's model is reasonably complete. However, Hauschildt arrived at his model qualitatively. Hence, our study enriches Hauschildt's work by providing quantitative data that leads to a model that reflects Hauschildt's success dimensions. More generally, our study adds value to all qualitative studies (e.g., [31]) by using a method that enabled the collection and analyses of both qualitative and quantitative data. Moreover, by using semi-structured questions, the repertory grid method overcomes the problems of repeatability [10] of many qualitative data collection methods, in which the questioning and the attention paid to various themes may differ in different interviews.

Furthermore, this study added value to the innovation management literature by selecting an alternative method, namely Kelly's repertory grid method. Even if project performance had been broadly discussed and even if some findings were not novel, it is interesting to see insights acquired from the literature confirmed by an alternative research approach. The repertory grid method moreover allows its users to overcome some major shortcomings of the existing literature on project performance.

The few studies that claimed the multidimensionality of the construct mainly started from the assumptions made by other researchers and did not deal with the available measures as such. In contrast, the repertory grid method did not make any preliminary assumptions on project performance. It elicited the *practitioner's view* of project performance without imposing the researcher's frame of reference. The method, which derives from cognitive research, enabled the recognition of different cognitive structures of the people in our study. It delivers data richness. For example, aspects that the interviewee was not conscious of or had never thought of came to the surface. Very subjective dimensions were elicited as well (cf. [27]). In addition, by comparing triads, a project was lifted from its historical context and put into a wider perspective [25], which again positively affected the data richness. Furthermore, the comparison of various triads as well as the unravelling questions from the researcher—such as, 'In which way? What makes it like that?'—made it difficult for the interviewee to withhold or distort the truth during an hour and a half. As a result, the likelihood of capturing truthful data was high.

The repertory grid method enables the elicitation of success measures but also of potential success determinants. The standard methodology to search for success determinants consists of retrospectively analysing the characteristics of successful or failed projects, or by conducting paired comparisons and discriminant analyses of successful and failed projects. These studies were often

based on close-ended questionnaires [25]. The repertory grid method allowed some major shortcomings of these studies on success determinants to be overcome.

It avoided the classification of a project as a success or a failure and excluded any preliminary assumption on the project performance, on which no consensus has yet been obtained. Furthermore, by using semi-structured questions, the method avoided the typical disadvantages of often-used questionnaires to study the theme. For example, it allows the interviewee's cognitive constructions of the phenomenon of interest to be tapped, instead of forcing the constructions to fit into the cognitive structure of the researcher. At the same time, it avoids the typical disadvantages of open-ended questionnaires or interviews: the interviewee does not feel uncomfortable. Even more, in our study, most interviewees found the exercise intriguing and novel, because they were making ideas explicit in a way they had not done before (cf. [25]). Moreover, it concerned 'their' ideas based on their own unique experience, background and interest (cf. [68]). Nevertheless, we note that the pleasant character was disturbed as soon as a saturation effect occurred.

Shortcomings

The in-depth repertory grid interviews are time-consuming and labour-intensive. Hence, only small samples can be examined, which limits the general application of our results. Furthermore, the interviewees respond within certain limits. For example, in our application only three product development projects at a time were compared to elicit the dimensions. Unfortunately, these three projects might not represent all dimensions. As a result, the elicited dimensions are range-restricted ([70], p. 71). We tried to reduce this disadvantage by taking into account several projects and by composing several triads of projects. Furthermore, it is clear from our experience that a main characteristic of the method, namely not influencing the interviewee, requires some practice [10].

Therefore, the first three interviews were only used as learning cases and were not adopted in the analyses.

CONCLUSION

Our study tried to answer the question: ‘how do we map project performance unambiguously?’ [42]. If the old saying ‘what gets measured, gets managed’ is true, and we think it is, then it is obvious that one should avoid a situation where the measures are wrong or incomplete [76].

Most practitioners and researchers have looked at the performance of product development projects from a particular, rather limited point of view. However, more and more, the importance of an integrative and multidimensional approach has been put forward [39,78]. Our study confirmed this stream of literature. More particularly, project performance can be represented by a three-polar model, containing process, economic and indirect poles. Each of these poles includes various success aspects. The process pole includes such aspects as respect for time, budget and technical specifications. The economic pole refers to financial and commercial measures. The indirect pole includes the project’s contribution to prestige and business success, respect for innovativeness, and knowledge creation and transfer. Hence, the model points to a wide variety of aspects that should be taken into account. It argues for a balance between internal and external, short and long term, future-oriented and past-focused measures. Striving for a balanced and integrated performance is in line with the trends of performance measurement at the organisational level [26,29,46,47]. We note that no differences in our performance model seem to appear at the different stages of the development process. However, although the global structure is not contingent on time, the relative importance of the various success aspects may differ over time [42]. Our study further stresses that, in measuring project performance, customer and strategy should be major points of reference.

Ideally, these points of reference are inter-related: the strategy should take the customer into account.

Value added to the literature

The developed performance model enriches the existing literature by integrating and extending various success models. Previously, the indirect success aspects have generally been neglected. Furthermore, our study delivers a clear and refined view of project performance by using an alternative research methodology.

Value added to practitioners

The study proposes a project performance model to companies that invest in R&D. It reveals which aspects should be taken into account when setting measures of assessment prior to project start. Managers should quantify the expected benefits and determine the relative importance of the various success aspects, which may be time-related [42,78]. The appropriate performance measurement system and expectations for each success dimension vary by individual project, depending on the strategy undertaken for each project [34]. Hence, companies should first carefully determine the project objectives, secondly select the most appropriate strategy to achieve these objectives and then construct a performance measurement system that enables verification of whether the objectives were realised. During project execution, it is important for managers to keep their people focused on the pre-specified measures and motivate them to achieve the objectives along the various success aspects. Success with one aspect does not necessarily mean success with other aspects [23]. Moreover, firms must frequently sacrifice some level of success on one dimension to achieve success on another [34]. The proposed model enables progress to be recorded and output realised, which can then be compared with the expectations [21]. We stress that, besides

performance measurement at the project level, the other levels to measure performance are insightful to the organisation as well.

Future research

This study delivered data richness but limited the general application of the results. It would be interesting to replicate the study in other settings. For example, one may verify whether the three-polar model may be applied in other sectors and companies (e.g., non-profit organisations) or whether it remains valid in other countries. We also stress that it is useful to apply one single model in all future research on success determinants. It then becomes much easier to compare findings and make conclusions. The literature suggests splitting our respect for budget and technical specifications into a budget related subgroup and a technical subgroup. It also hints at splitting the financial and commercial aspect into a pure financial and a pure commercial subgroup. These suggestions can be tested by future research. Nevertheless, they appear to leave the global structure of the three-polar model unchanged. Finally, we note that the repertory grid method seems useful for exploratory research in innovation management. It allows the collection and analysis of both qualitative and quantitative data. The structure as well as the content of the interviews can be analysed. Besides selecting projects as 'elements', the 'elements' may be people, other objects, or they may be properties of people or objects [43,71] such as innovation strategies. Hence, the range of applications is broad.

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TABLE 1

Some major studies that considered project performance as a multidimensional construct

Study considered	Number of measures	Number of groups of measures	Source of data	Method to identify dimensions	Grouping method
Hauschildt, 1991	19	3; 6 subgroups	30 empirical investigations	Survey analysis	Qualitative grouping by the author
Freeman and Baele, 1992	*	7	14 articles	Literature review	Qualitative grouping by the author
Griffin and Page, 1993	75	5	77 articles, 50 practitioners	Literature review, open-ended questionnaire	Two Japanese management tools in expert groups to group similar attributes together; correlation and factor analysis on the survey data as validation tests
Shenhar, 1997	13	4	182 project managers and literature	Literature review (4 articles)	Qualitative clustering by the author and tests by means of factor analysis

*Legend: * = not indicated in the article*

TABLE 2a

The sample of interviewees

Company	Number of interviewees	Number of projects	Mean duration of an interview (minutes)	Number of interviewees from				
				R&D* HR**	Mfg* Eng**	Marketing * Logistics**	Quality* Accounting **	Purchase* Sales**
A'	5	6	103	2*	2*	1*	0*	0*
B'	6	7	77	3*	1**	0*	1*	1*
C'	6	6	84	0*	2*	0*	4*	0*
D'	6	6	91	1*	2*	2*	0*	1*
E'	7	6	81	2*	2*, 2**	0*	0*	1*
F'	6	6	80	1*	1*, 3**	0*	1*	0*
G'	8	6	92	3*	2*	1**	1**	1**
H'	9	6	91	4*, 1**	1*, 1**	1*	1*	0*
(total)	*(53)*	*(49)*	*(4629)*	*(16*, 1**)*	*(12*, 6**)*	*(4*, 1**)*	*(7*, 1**)*	*(3*, 1**)*
μ	6	6	87	2	1	0	1	0

Legend: R&D: research and development, HR: human resources department; Eng: engineering; Mfg: manufacturing.

TABLE 2b

The sample of companies

	< 100 people	**100 à 250 people**	**> 250 people**
1 to 5 R&D people	1 company	1 company	1 company
6 to 15 R&D people	1 company	1 company	1 company
More than 15 R&D people		1 company	1 company

TABLE 3
The seven-dimensional model of project performance

S1. Respect for time	α = 71%	a) Respecting the initial planning b) Presenting an efficient product development c) Exceeding the planning at the end d) Being on time in the market
S2. Respect for budget and technical specifications	α = 59%	a) Respecting the budget provided initially b) Exceeding the budget at the end of the project c) Reaching the initial expectations on technical specifications
S3. Knowledge creation and transfer	α = 74%	a) Creating a spin-off to other products b) Allowing a considerable learning effect during product development
S4. Contribution to prestige	α = 90%	Contributing to the prestige of a) Design b) The project leader c) Marketing d) Production
S5. Respect for innovativeness	α = 94%	Reaching initial expectations on a) The innovativeness of the project b) The uniqueness of the project
S6. Contribution to business success	α = 89%	a) Building a positive image of the company b) Contributing to the innovation profile of the company c) Causing the firm's growth d) Acquiring greater market share e) Having a large impact on the company's future
S7. Financial and commercial success	α = 90%	Reaching initial expectations on a) Commercial results b) Cash-flow generation c) Profit generation
The principal component analysis (Varimax or Oblimin rotation) on 53 cases was found to be stable, with loadings exceeding 0.6 on average. The Kaiser-Meyer-Olkin measure of adequacy is 0.627. Two success measures were eliminated because they loaded on several factors and were deemed unstable. One concerned the project's contribution to the company's strategy, the other the degree to which customer expectations are met.		

TABLE 4

The seven success aspects positioned within the literature

	Project-level measures						
Our model	**S1.**	**S2.**	**S3.**	**S4.**	**S5.**	**S6.**	**S7.**
Cooper and Kleinschmidt [16]			a3			a3	a1, a2
Hauschildt [39]		b1, b2	b1	b3		b2	b2
Freeman and Baele [31]	c2	c1, c2, c5, c6, c7	c6, c4	c4	c 6		c7
Griffin and Page [35]	d5	d5	d3	d5		d3, d5	d1, d2
Shenhar [78]	e2	e1, e2	e4			e4	e1, e3
BSC [46][47]	f3, f2	f3, f2	f4		f2, f3	f2, f4	f1, f2

Legend: ***Our model:*** *S1: respect for time, S2: respect for budget and technical specifications, S3: knowledge creation and transfer, S4: contribution to prestige, S5: respect for innovativeness, S6: contribution to business success, S7: financial and commercial success.* ***Cooper and Kleinschmidt:*** *a1) financial performance, a2) market impact, and a3) window of opportunity.* ***Hauschildt****: b1) technical success, b2) economic success, b3) other success measures.* ***Freeman and Baele****: c1) technical success, c2) efficiency of project execution, c3) managerial and organisational success, c4) personal growth, c5) completeness, c6) technical innovation, c7) commercial success and manufacturability.* ***Griffin and Page:*** *d1) customer-acceptance, d2) financial, d3) firm-based, d4) programme and d5) product-level measures.* ***Shenhar:*** *e1) customer satisfaction, e2) budget and schedule, e3) contribution to business success, e4) future potential.* ***BSC****: f1) financial perspective, f2) customer perspective, f3) internal business perspective, f4) innovation and learning perspective.*

FIGURE 1

the three-polar model of project performance