"AN EMPIRICAL STUDY OF CAPITAL BUDGETING PRACTICES FOR STRATEGIC INVESTMENTS IN C.I.M. TECHNOLOGIES"

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Abstract

In recent years, an increasing number of companies have been struggling to justify strategic technology investments using traditional capital budgeting systems. The existing accounting-based decision models (such as discounted cash-flow) are said to be no longer adequate to help evaluate investments in technological innovation, mainly because of the strategic, intangible nature of the benefits involved. As a result, traditional capital budgeting methods have been heavily criticized of discouraging the adoption of advanced manufacturing technologies and thus undermining the competitiveness of western firms. Some authors would argue that the only alternative is to exempt these strategic investments from the control of accounting systems, while others have developed sophisticated methods for performing an integrated strategic and financial investment analysis. At this point, however, it is still unclear which approach is prevalent in practice and which factors contribute to effective investment decisions.

This empirical study attempts to shed some light on the problem by examining the capital budgeting practices of firms as applied to strategic investments in Computer-Integrated Manufacturing (CIM) technologies. Questionnaire data are used to provide a better insight into the ways in which manufacturing firms go about controlling major investments in technological innovation. In addition, tentative findings are presented about hypothesized relationships between characteristics of the investment decision making process and the perceived *ex post* financial performance of CIM investments.

Keywords: Capital budgeting, strategic investment, CIM technology.

1. INTRODUCTION

This research study investigates companies' capital budgeting practices with respect to strategic investments in advanced manufacturing technologies. The problem of efficient allocation of scarce capital resources to identified investment opportunities, generally referred to as capital budgeting, continues to fascinate both academics and practitioners. The strong interest in this subject can be explained by the fact that capital investments are an important part of the process whereby a firm creates value and can thus have significant implications for the company's competitive position.
This holds certainly true for large-scale investment projects in Computer-Integrated Manufacturing (CIM) technologies, such as Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM), Flexible Manufacturing Systems (FMS), Automated Storage and Retrieval System (AS/RS), etc. The decision to commit resources to this type of investment follows from a company's business and manufacturing strategy which are aimed at developing new manufacturing capabilities in order to create or sustain a competitive advantage in the market place.

The theoretical advances in providing sophisticated capital budgeting techniques for evaluating investment projects have been numerous and continue to come forward. The underlying assumption of these methods is that only investments with an expected return in excess of some minimum required hurdle rate will eventually create value for the firm.
In recent years, however, many authors have claimed that a narrow focus on capital budgeting techniques for evaluating strategically important capital investments is inappropriate as it may lead to investment myopia, in particular, create a bias against strategic investments in new manufacturing technology. Traditional methods of investment appraisal have been critized for not providing the right information needed to evaluate and support technological innovations in manufacturing. As a result, proponents of strategic investment justification as well as integrated strategic-financial models have advocated alternative decision models.

The literature abounds with surveys on the use of traditional capital budgeting techniques. However, the actual use and the appropriateness of the various approaches to evaluating CIM-related investments has not been empirically verified. That is, the features of the capital budgeting system as

well as their relationships with other organizational elements and the project's *ex post* performance remain largely untested.

This study seeks to address the following research questions:

- What are the characteristics of companies' capital budgeting systems employed for controlling and evaluating investments in CIM technologies? In particular, to what extent do companies rely on standard capital budgeting methods for the justification of this type of investments?
- What is the influence of other financial control systems and organizational elements on companies' decisions to acquire CIM technologies?
- Is there any relationship between the characteristics of the investment decision process and the *ex post* performance of CIM investments?
- In what way - if any - are the firm's planning and control systems with regard to capital budgeting integrated with the company strategy?

Section 2 of the paper broadly reviews the existent literature about the evaluation of capital investments, both in general and more specifically for strategic investments in CIM technologies. The third section presents some methodological details on the survey that was conducted for this study. Section 4 reports the main findings from our data analysis, and the final section five wraps it up with some general conclusions and suggestions for further research.

2. LITERATURE REVIEW

2.1. Investing in CIM Technologies to Create a Competitive Edge

Having gained a better understanding of the nature of the relationships between cost, quality and dependability, today's manufacturers face the challenge to increase their responsiveness and to use manufacturing flexibility, along with the other capabilities, as a competitive weapon in today's rapidly changing and highly competitive market place. The increased global competition, the shortening of product life cycles, the need for more customization and the rapid rate of technological change all contribute to the increased interest in advanced manufacturing technologies.

The adoption of CIM technologies enables firms to survive in the new business environment by providing them with the ability to compete in ways that were not feasible before because of the limits of existing technology. Advanced computer-based technologies may indeed open up levels of overall process efficiency, accuracy, and product-line variety never before realized, and allow the companies acquiring them to maintain or gain a competitive edge. The key promises of CIM technologies appear to be in reduced direct and indirect manufacturing costs, higher quality levels, shorter throughput and change-over times which result into improved responsiveness and less inventory. Especially the time-related benefit has attracted a lot of attention, because it allows for more rapid product turnover and for the realization of so-called "economies of scope" (i.e. a broader range of products can be economically produced in the same facility).

This study aims at examining the capital budgeting process of manufacturing companies involved in the decision making about whether or not to spend a substantial amount of money to acquire some type of CIM technology. The investments in manufacturing technology to be included in our study are selected on the basis of their strategic importance to the firm in that they represent a relatively high proportion of the business unit's total investment outlays and that the firm's future survival is regarded as being dependent upon it.

Large-scale investments in CIM technologies inevitably require substantial initial capital outlays. From a capital budgeting standpoint the question automatically arises whether the expected benefits from the adoption of these technologies can offset the additional investment compared to conventional

non-flexible systems. As will be discussed later, a great deal of the long-term "strategic" benefits which result from the adoption of CIM cannot be readily expressed in monetary terms. This causes serious problems for the financial evaluation which is purely based on dollar input. Because the technology is most likely to be new to the company, there is also greater uncertainty about the cash-flows associated with this type of investments.

Moreover, when a computerized manufacturing system is introduced in the factory for strategic reasons, we usually do not deal with a stand-alone project but with an investment that has a major impact on the entire logistics organization and that may be interrelated with other projects. Strategic investments in CIM should thus rather be seen as part of an overall investment plan whose ultimate objective is to realize lean manufacturing operations.

The strategic issues related to the adoption of CIM technology and the high degree of uncertainty involved explain why these investments may not fit into the traditional capital budgeting model which evaluates investment projects on an individual and purely financial basis.

2.2. The Capital Budgeting Decision

The term investment refers to "commitments of resources made in the hope of realizing benefits that are expected to occur over a reasonably long period of time in the future". [Bierman and Smidt (1988), p. 4]. The fundamental goal of the firm is considered to be the maximization of value, which is generally accepted as the only rational basis for making capital budgeting decisions. That is, a firm should not accept a project because it looks intuitively feasible, but only when it has been demonstrated that the investment increases the value of the firm.

2.2.1. Economic evaluation of investment projects

Capital budgeting theory implicitly assumes that all projects are evaluated based on economic merit. Consequently, project selection rules consistent with the value-maximizing goal have been defined. Building upon certain economic assumptions, among which the time value of money, risk aversion, and an assumed goal of value maximization, discounted cash-flow (DCF) models, such as net present value (NPV) an internal rate of return (IRR), have been advocated in the literature as sophisticated capital expenditure evaluation techniques. The NPV is to be interpreted as the addition to the value of

the company which can be obtained by making the investment. Hence, the decision criterion is that projects with positive NPVs should be accepted and those with negative NPVs should be rejected. More common, and perhaps intuitively easier tools such as the pay-back period (i.e. the time taken for a project to recover its initial investment) have been criticized for failing to make correct assessments of project value.

Hurdle rate

Finance theory states that each investment project should be evaluated at its own opportunity cost of capital and that the true cost of capital depends on the use to which the capital is put [Brealey and Myers (1988), p. 198]. As such, the so-called "hurdle rate" or "discount rate" or "opportunity cost of capital" used in the NPV analysis should account for the risk that is proper to the project.

The extant survey literature [Gurnani (1984)] shows that, in practice, the method of determining the hurdle rate and its numerical value vary widely. Risk-adjusted weighted average cost of capital appears to be favored, as well as a cut-off rate based on subjective judgement.

Risk Analysis

The notion of "risk" in the context of capital budgeting analysis refers to the fact that the decision-maker is uncertain as to the precise outcomes of the investment decision (i.e. the cash-flows that will be generated by the project), which may involve undesirable consequences or losses. In other words, risk is generally perceived by executives as the probability of not achieving a given target return or the degree of downside deviation from the expected return.

The risk handling methods cited in the capital budgeting literature basically take two forms. One is the simple risk-adjustment method, which is based on deterministic estimations and intuitive adjustments to either the underlying cash-flows or the evaluation criteria. Examples are: decreasing the expected cash-flows, increasing the discount rate or shortening the required pay-back period.

The second approach is borrowed from the management science literature and is generally referred to as "risk analysis". It implies an evaluation of the uncertainties associated with critical variables through assigning probabilities to possible outcomes and producing a range of results which can be evaluated for acceptability. Commonly employed techniques are: sensitivity analysis, comparative analysis at

optimistic, pessimistic and most likely estimates, simulation based on probability distributions of cash-flows and certainty equivalent.

Surveys indicate that the majority of the firms rely on intuitive judgement to account for risk in capital budgeting instead of using some formal method, although it is suggested that more sophisticated methods are finding increasing usage [see Gurnani (1984)].

2.2.2. Investment Decision Making within an Organizational Context

The preceding section briefly described the most common financial techniques for evaluating investment proposals. They have also received much attention in the normative literature and in previous research. However, investment appraisal is but one step in the overall capital budgeting process and the methods described above are but one element of the organizational control system designed to channel capital investments in the desired direction.

In this section we will first describe the formal accounting procedures that exist in many companies to guide the capital budgeting process. Next, we summarize some interesting findings from previous research on the organizational aspects of the investment decision making process.

Formal Capital Budgeting Procedures

Anthony *et al.* (1984) describe the elements of a formal capital budgeting system as follows:

- The originator of a proposal prepares a description and justification of the proposed investment;
- A high-level staff-unit analyzes the proposal and submits its recommendations to top management. For important projects, this stage of the process may require a lot of discussion and staff work on details of the proposal;
- The proposals are aggregated in a capital budget, which is usually prepared once a year and separately from the operating budget. Projects are often classified under different headings (e.g. cost reduction and replacement, expansion of existing product lines, new product lines, etc.) and are prioritized within these classifications;
- The capital budget is revised, if necessary, and finally approved by top management. In preparing the capital budget, management must appraise individual projects as well as the total amount of

funds requested. If it turns out that this total exceeds the amount that the company is willing to spend, then some projects are deleted, reduced in size or deferred;

- To obtain the final approval to proceed with a particular project, a specific capital authorization request has to be prepared for the project. Most large companies have standard procedures which contain instructions showing how to perform a detailed project analysis. These authorization requests are approved at specified levels in the organization depending on the magnitude of the capital expenditure involved;
- Once its implementation has started, management control systems are used to monitor the performance of the project;
- Finally, the company may have post audit procedures to follow up on capital projects once they have gone into operation in order to find out whether the original estimates of costs and benefits are realized in practice.

The organization's formal capital budgeting procedures typically describe a bottom-up capital budgeting process, that is, companies are assumed to let investment proposals bubble up from plants for review by division management and then by senior management. The ultimate authority for investment decisions rests with top management (the Board of Directors or the CEO). A limited amount of this authority may be delegated to lower level managers, with different spending limits assigned to different hierarchical levels.

A survey conducted by Scapens and Sale (1981) showed that most companies controlled the type of proposals received via the capital expenditure budget together with broad guidelines from company headquarters as to what constituted acceptable proposals. The average ceilings for individual projects appeared to be quite low, which leads the authors to conclude that divisions have only limited capital expenditure autonomy.

Impact of Financial Control Systems and Organizational Characteristics on the Investment Decision Process

Most research on capital budgeting practice has focused on the rational economic analysis of investment proposals. What has been ignored in many studies, is the inherent dependence of the capital budgeting process upon the organizational context. In this paragraph we provide a brief

summary of the way in which certain aspects of the organization, in particular the financial control systems, may impact the investment decision process.

Bower (1970) describes the capital budgeting process as a process whereby an investment project is conceived at a lower level of the organization. As the project gradually progresses up the hierarchy, it is evaluated and supported by progressively more senior managers. This way, an investment which is passed to top management for approval, will have received the commitment of a large section of the organization. Consequently, it may be very difficult for corporate management to reject such a project. Bower's findings suggest that much of the analysis and decision making in capital budgeting is conducted at lower levels in the organization and merely "rubber stamped" at the executive level. Such arguments cast doubt on the proposition that investment decisions are made by top management and that the formal systems for authorization of capital expenditures severely restrict divisional managers' capital investment autonomy.

In another study, Carter (1971) observed that capital budgeting decisions are made on the basis of various treshold levels which are determined by top management's perception of the project champion's record. The argument that tightness of the tresholds is a function of the competence of the project sponsor, is frequently observed in practice. Mukherjee and Henderson (1987) found empirical evidence of such subjective assessments where "the sponsor is appraised every bit as much as the proposal" [Pike (1983), p. 203].

From the literature on CIM investments we conclude that the project leader can have a crucial impact on the investment's success [Beatty and Gordon (1991); Beatty (1992)]. If a firm undertaking an investment in CIM technology can count on a competent project leader who is able to realize consensus between all parties involved and who is a committed "champion" actively promoting the project's progress, they feel that they are facing less risk because the project leader will do everything to get the best out of the investment.

Several researchers have explored the role that performance evaluation and reward systems play in promoting desirable capital budgeting behavior. Pinches (1982) draws the attention to the problem that management controls are often not designed to complement the firm's capital budgeting operation. Performance is evaluated on the basis of short-term accounting critera which are

incompatible with the long-term goals and strategies of the firm. The author warns that this may lead executives to view the problem as one of knowing how to generate the "right" numbers in order to get a project approved. Similarly, Scapens and Sale (1981) and Kaplan (1984) suggest that inappropriate performance evaluation and reward structures can create dysfunctional behavior in the organization and distort the resource allocation process.

After having discussed the characteristics of the capital budgeting process in general, we now turn to the literature which deals more specifically with the investment justification of CIM investments.

2.3. Capital Budgeting for Strategic Investments in CIM Technologies

The literature on capital budgeting for investments in advanced manufacturing technology is primarily concerned with the debate about the role of financial calculations and strategic issues in the investment justification. The objective of this section is to provide an overview of the various streams of thought which exist in the literature.

2.3.1. Shortcomings of Traditional Capital Budgeting Methods

Critics of the traditional capital budgeting methods argue that the focus of the financial analysis is too narrow and that it does not enhance the manager's ability to make important strategic decisions in line with the long-term goals of the firm. Hayes and Garvin (1982) claim that the extensive use of DCF techniques has been responsible for a decline in the capital expenditures of business firms, which in turn has caused a decline in their competitiveness: "the willingness of managers to view the future through the reversed telescope of discounted cash-flow is seriously shortchanging the futures of their companies." [Hayes and Garvin (1982), p. 72].

Careful reading of the various comments on DCF indicates that we should make a distinction between 1) claims that the bias against strategic investments is an inherent problem of DCF theory, and 2) the criticism of those who argue that it is the misuse and not the technique itself that leads to the undesirable effects.

Some authors [Myers (1984); Hayes *et al.* (1988)] claim that major difficulties arise from the constraints of the underlying theory. Hayes *et al.* (1988) consider three problems in this regard:

* The established capital budgeting paradigm does not accommodate **interdependencies between investment projects**. This is particularly important for the justification of investments in CIM technologies because the full benefits from such major investments may only realize when the CIM system is viewed as a whole, whereas each component individually may not meet the corporate profitability criteria.
* With regard to the choice of the **planning horizon**, Hayes *et al.* (1988) argue that one should not focus exclusively on initial projects, but also take into account the follow-on investments. Narrow use of the NPV criterion will favor expanding an existing facility rather than building a entirely new one because less initial investment is required and the returns are more immediate. In the long run, however, such a series of piecemeal investments can lead to outdated facilities. Therefore, it is important to think of the alternative futures (both in terms of the financial consequences and the competitive position) each investment proposal may create for the firm.
* The third problem relates to the **incorporation of the learning and option content** of an investment into the analysis. If the value of a project mainly comes from new knowledge or from providing the firm with profitable opportunities for later investments, applying standard capital budgeting procedures can be a meaningless exercise.

On the other hand, the literature discusses a series of problems relating to poor implementation of the theory of capital budgeting. Kaplan and Atkinson (1989) have summed up the main deficiencies in the investment justification of advanced manufacturing technologies, among which are:

* The use of **excessively high hurdle rates** that bear little resemblance to the firm's real opportunity cost of capital, due to an incorrect treatment of inflation or an arbitrary adjustment for risk. Sometimes a high hurdle rate is used to put pressure on managers (by challenging them with a difficult-to-achieve target), but such practice undermines its value as a criterion for evaluating investment opportunities. Raising discount rates arbitrarily on an *ad hoc* basis will systematically penalize projects with long-term benefits such as strategic investments in CIM technologies.

* **Incorrect base-case forecast**. It is incorrect to assume that companies that do *not* invest in CIM technologies will enjoy a continuation of the status quo. Instead, they will face a decline in net cash-flows in future years because competitors will take their market share if they do not maintain technological leadership.

* **Failure to recognize all the benefits** and, in particular, **omission of strategic, non-financial benefits** in the DCF calculations.

  Besides the common savings in material, labor and energy, innovative manufacturing technologies also provide other tangible benefits that are not readily measured by traditional capital budgeting systems, such as inventory reductions, improved quality, and reduced floor space requirements. The process flexibility, higher quality, and better scheduling that are typical of CIM-related technologies, will indeed drastically cut both work-in-process and finished goods inventory levels. Moreover, these new manufacturing technologies will allow better conformance to specifications and a significant decline in defect rates.

  Other CIM-related benefits include increased flexibility in terms of economies of scope, faster response to changes in market demand, and reduced lead times. In addition, there is the aspect of organizational learning: the start-up costs of introducing a new technology will also be beneficial to other similar projects in the future, so it is not fair to assign them entirely to that specific project only. Furthermore, a decision to invest in CIM technologies provides the firm with the opportunity to participate in future enhancements. In other words, they have acquired a technology option. In contrast to the above-mentioned tangible benefits, the flexibility-, learning-, and option-related benefits which are expected to result from the introduction of advanced manufacturing technologies, cannot be easily quantified. However, according to Kaplan (1986), there is no reason to value them at zero: "Conservative accountants who assign zero values to many intangible benefits prefer being precisely wrong to being vaguely right." [Kaplan (1986), p. 92]. To leave the qualitative considerations out of the analysis biases decisions against investments that are likely to have a significant strategic impact, such as investments in technological innovation which have the potential to drastically improve the plant's competitive abilities.

* Another problem with current capital budgeting practice is its **bias toward incremental rather than global projects**. The capital approval process specifies different levels of authorization depending on the size of the expenditure. This kind of procedure, however, may create an incentive for lower level managers to come up with small projects to consciously avoid certain decision channels. Over time, this may result in a suboptimal pattern of incremental investments and even lead to an obsolete factory. By investing on a piecemeal basis, the plant will indeed never get the full benefit from a completely reequiped production facility.

As a consequence of these alleged shortcomings of the traditional capital budgeting system, investments are said to be biased towards short-term projects with easily quantifiable benefits, at the expense of long-term strategic investments whose principal benefits involve developing new manufacturing capabilities.

2.3.2. The Role of Financial Appraisal in Capital Budgeting of CIM Technologies

We mentioned in the previous section that Kaplan (1986) argued that DCF techniques are not inappropriate, but just improperly applied. For instance, he considers intangible benefits as effects which are difficult but not impossible to quantify. Kaplan concludes that the challenge for managers is to improve their ability to estimate the costs and benefits of new manufacturing technologies, not to discard the financial analysis.

Finnie (1988) presents an argument along the same lines, that it is the quality of the analysis which fails to properly justify investments in CIM technologies, not the analytical model itself. According to the author, much of the criticism of traditional accounting techniques is based on the erroneous reasoning that, because there are weaknesses in the conduct of capital expenditure appraisals, there is no reason for having financial appraisal at all. The author offers a number of arguments against abandoning financial appraisal in the investment decision process, stating that the pursuit of broad strategic goals, such as increased market share, does not avoid the issue whether satisfactory financial results can be achieved.

In short, authors in the accounting stream of the literature are convinced that the traditional capital budgeting analysis is still valuable and that the expected financial return of the investment should play a key role in the decision making about the acquisition of new technology.

2.3.3. Evaluation of CIM Investments from a Strategic Perspective

In reaction to the above-mentioned shortcomings of the traditional financial analysis, several authors have argued that investments in new technology should not be justified based solely on their capacity to create economic value for the firm, but on an evaluation of their consistency with the competitive strategy of the company [Hill (1985); Goldhar and Jelinek (1983)]. Proponents of strategic investment appraisal claim that any purely quantitative approach is inevitably short-sighted and advocate that strategic considerations should override financial arguments.

The inability of many investment decision makers to include the intangible benefits in their evaluation is seen as a proof of the failure of the traditional investment appraisal techniques. Besides, it has become fashionable to attack DCF by stating that the Japanese do net get caught up in DCF number games but take a long-term perspective focused on building market share, and that their approach has clearly paid off. These arguments have resulted in the widespread belief that investment in CIM technologies must be made as an "act of faith, a belief that the future will be as promising as the present, together with a commitment to making that future happen" [Hayes and Garvin (1982), p. 79].

Many would agree that the traditional financial analysis is too restrictive when it comes to evaluating strategic investments in advanced manufacturing technology. To exempt major technology investments from any kind of formal analysis, however, is often considered to be just as misguiding. A number of publications recommend the use of strategic frameworks to highlight the strategic aspects of the capital investment decision.

For instance, Partovi (1990) proposes a prescriptive methodology relating manufacturing strategy to the choice of technology. The model is presented in the form of a hierarchy which includes three groups of elements: 1) the strategic forces driving competitive advantage (cost, quality, flexibility, delivery), 2) the activities along the organization's value chain: inbound logistics, product design, manufacturing process, outbound logistics, sales and after-sale service [Porter (1985)], and 3) the

characteristics of available technologies. The framework helps evaluate how well a given technology contributes to a particular strategic objective (e.g. cost reduction) through specific activities in the value chain.

Bromwhich and Bhimani (1991) developed another structured approach to strategic investment appraisal of advanced manufacturing technologies. Their model focuses on an evaluation of the company's strategic plan and how the new technologies can be used to exploit strategic opportunities or remedy weaknesses. The types of strategic benefits to be expected from CIM technologies can be either related to the marketing strategy (product enhancement, diversification, or risk reduction), or to the internal strategy of the company (cost reduction, better control of production systems, improved organization, and beneficial interaction between different units of the organization).

From the above discussion we conclude that the problem of evaluating investments in CIM technologies revolves around two perspectives. The first is the traditional cash-flow view held by accountants and financial theorists. The second is a more qualitative view which justifies investments on "strategic" grounds despite their failure to pass financial hurdles. Opinions in the literature are divided about which evaluation criterion (strategic or financial) should prevail in the evaluation of technology investments if the firm is to end up with a successful project. In the next section, we discuss several approaches that have been suggested for uniting both perspectives.

2.3.4. Approaches to Integrating the Strategic and Financial Analysis of CIM Investments

Recently, there is a growing awareness in the literature that strategy and finance are intertwined and thus should not lead to conflicts. More and more authors are convinced that good investment appraisal requires that strategic and financial considerations be reconciled and integrated. They propose capital budgeting models that go beyond the traditional DCF calculation and reflect the strategic issues of investments in CIM technology.

One integrative approach has been advocated by Kaplan (1986) who argues that the investment justification of new technologies should not be based on faith alone. He proposes to **consider broader benefits** than the directly quantifiable cost savings, and believes it is the task of top

management to assess whether or not intangible strategic benefits outweigh the shortfall in a DCF calculation.

Other authors, however, believe that this type of investment appraisal, while being more organized than the act-of-faith approach, leaves too much room for subjective investment decision making. They try to eliminate this bias by focusing on the **quantification of all relevant costs and benefits** (also those that are generally considered intangible). Primrose and Leonard (1987) for instance, have developed a computer program to help production engineers quantify all relevant costs and benefits, and justify routinely computer-aided manufacturing systems.

Various authors suggest the use of a **Multiple Attribute Decision Model**, i.e. a sophisticated model of weighted investment attributes, which comprises both financial-quantitative and qualitative criteria for investment justification of CIM technologies [Berliner and Brimson (1988); Noble (1990); Falkner and Benhajla (1990)].

Tomkins (1991), however, considers scoring models of this kind to be of little value because they offer nothing more than a broad checklist of financial and non-financial factors and provide no real insight in what it takes to be successful in the market. Instead, any assessment of the cash-flows needs to be based on the degree to which so-called "order-winning criteria" [Hill (1985)], identified through an in-depth analysis of competitive strenghts and industry attractiveness, are enhanced.

Logue (1981) is one of the authors who recognized the promise that **option pricing models** might hold for evaluating "pure strategic" investments (i.e. investments that create themselves assets which take the form of strategic options for the firm). He criticized the traditional methods of capital budgeting for failing to give credit for created opportunities that would enhance the market value of the firm.

Kester (1984) also advocates the application of option theory to give a hard edge to the strategic side of the investment analysis. He claims that separate qualitative analysis for strategically important investments may compromise the corporate objective of value maximization when "strategic" importance becomes a much-abused argument for acceptance of weak projects based on blind faith or by force of personality. To allow a more disciplined investment appraisal the author proposes a framework that is rooted in option valuation theory. The basic principle of the options approach is to think of any future investment opportunity as a "growth option", which is analogous to a call option on

securities. Proponents of the option valuation approach to capital budgeting of CIM technologies claim that their perspective provides executives with a coherent framework, which focuses on the firm's key objective of value enhancement, and integrates strategic considerations logically and systematically into the capital budgeting process.

We conclude that various sophisticated techniques and frameworks have been developed to integrate the traditional financial investment analysis and the strategic justification of investments in advanced manufacturing technologies.

Meredith and Hill (1987) have examined the appropriateness of different approaches to investment justification and state that the relevance of economic, portfolio, analytic and strategic considerations is dependent on the level of system integration (fig. 1). The critical factor, according to the authors, is not the technology itself, but the intended use of the new system. The different acquisition purposes for CIM technologies, ranging from straightforward replacement for increased efficiency to complex integration for synergistic competitive advantage, can be placed on a scale based on the technology's level of integration. Meredith and Hill (1987) have defined four such levels: level 1 is defined as stand-alone or unitary equipment, such as machine tools or robots; level 2 consists of flexible cells, i.e. cellular groupings of equipment and materials for the production of families of parts (e.g. FMS); level 3 represents linked islands, which tie together pieces of a large functional area or separate functional areas (e.g. CAD/CAM); level 4 is the stage of full integration or Computer Integrated Manufacturing. As we move from level 1 to 4 on the scale, the expected benefits from the technology investment become less tangible, the scope of effects varies from local to system-wide, and the organizational impact as well as the risk increase.

It follows from fig. 1 that each investment evaluation method should be used where appropriate. We learn that traditional capital budgeting methods work well for investments of relatively short duration and easily measured benefits, but that justification techniques must be increasingly non-financial and geared toward strategic thinking as investment projects become larger, more complex, and promise less easily measurable benefits.

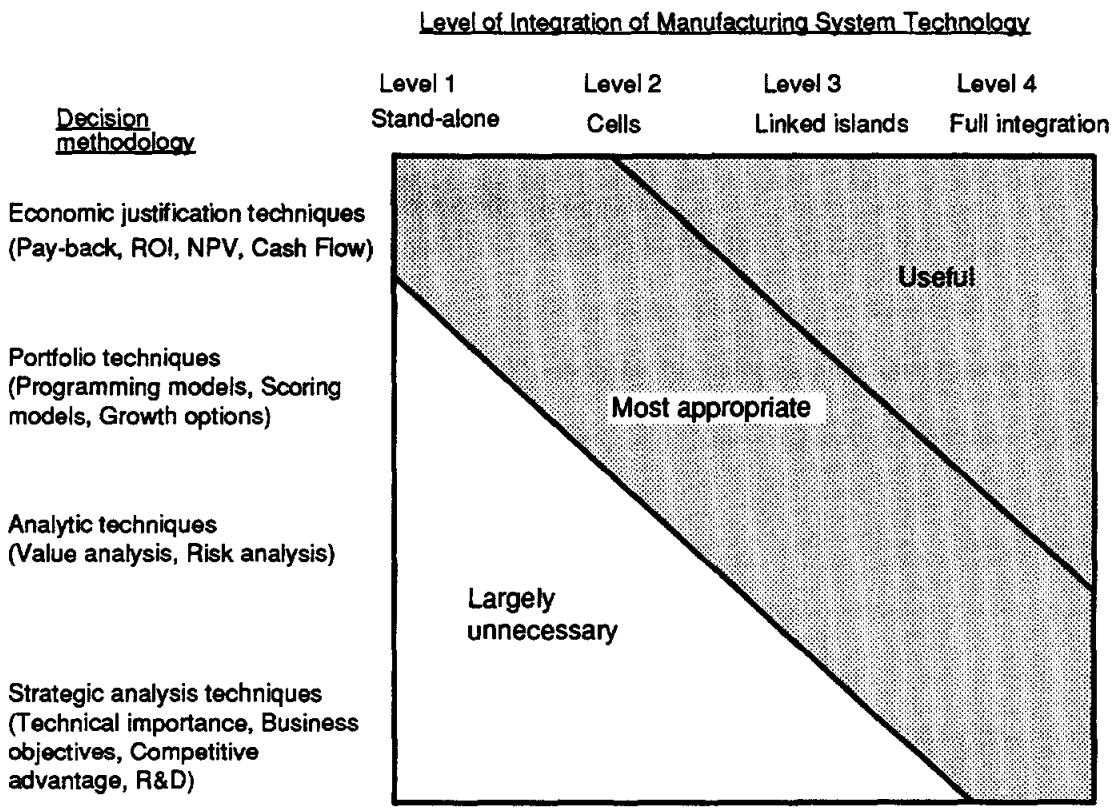

Fig. 1: Investment decision method and level of system integration [adapted from Meredith and Hill (1987)]

2.4. Conclusions from the Literature

Strategic investments in CIM technologies are intended to drastically improve the plant's manufacturing capabilities in order to create or sustain a competitive edge for the company. These investments, however, may be more difficult to evaluate using the standard capital budgeting systems because they usually entail intangible benefits and a relatively high degree of uncertainty with respect to the outcome.

Many articles have been published and continue to appear, discussing which evaluation criterion should prevail in the capital budgeting decision about CIM technologies in order to effectively select the most promising investments. One school of thought advocates that strategic considerations are of primary importance, while others argue that fit with the strategy itself is not sufficient and that an acceptable financial return is the only sound basis for investment decision making. More recently, there is a tendency to reconcile strategic issues with the financial analyses.

Furthermore, it has been suggested that other organizational elements, such as the performance measurement system and the presence of a project champion, may have an impact on companies' investment decisions about CIM technologies.

This study is aimed at exploring the capital budgeting practices of companies with regard to strategic investments in CIM technologies. It also attempts to provide some empirical evidence to support the hypothesized relationships between the investment decision process, certain characteristics of the organization, and the *ex post* performance of CIM investments.

3. THE SURVEY

The study was part of a larger research project aimed at getting a better insight into the current state and planned future developments of CIM technologies in Europe. Data for this part of the project were collected from production managers at 42 European firms that had recently been involved in investments in CIM technology. The firms in the sample represented a variety of industries including electronics, chemicals/pharmaceuticals, food processing, textile, telecommunications, machinery, etc.

Data were collected by means of a mail questionnaire (see Appendix)[1]. The questionnaire was developed and refined on the basis of field interviews with senior managers in 10 manufacturing firms in Belgium.
Most questionnaire items of interest were measured on a 7-point Likert scale, with the exception of a number of questions where respondents were asked to provide financial data. The questionnaire was mailed to plant managers, CIM managers and controllers in manufacturing companies that were selected from several data bases on the basis of the likelihood that they had undertaken major investments in CIM technologies in the past.

Because of the sensitive nature of some of the questions asked and the level of detail sought, the anonymity of the respondents was assured in a cover letter explaining the purpose of the study. Even so, a large response rate was not anticipated. Follow-up telephone calls to a randomized sample of nonrespondents brought the total number of returned questionnaires to 42, all of which were usable. Although we asked explicitly to distribute the questionnaire to several key persons in the organization involved in the investment decision making process for one particular CIM project of their choice, we got only one respondent to fill out the questionnaire in each company.
Based on the additional comments and information provided by several respondents and by cross-checking the answers on some of the questions, we concluded that the questionnaires had been filled out in a consistent and considered manner.

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[1] The questionnaire was in English or French depending on the country it was being sent to.

4. SURVEY RESULTS

Because of the small sample size it was not feasible to perform sophisticated statistical analyses. The conclusions reported below are mainly based on frequency distributions and qualitative analyses of the data gathered from our respondents.

Profile of the sample

The investment projects contained in our sample required an average capital outlay of 5 million ECU, ranging from 50,000 ECU to 42 million ECU. Most related to the adoption of leading edge technology and represented a major innovation for the adopting companies. Investments in Computer Aided Design (CAD)/ Computer Aided Engineering (CAE), Computer Aided Manufacturing (CAM), and linked CAD/CAM systems together accounted for half of the projects in the sample. Computer Aided Process Planning (CAPP) and Flexible Manufacturing Systems (FMS) represented 17% and 14% of the cases respectively. About two-thirds of all projects involved integrated systems. About 76% of the projects under consideration were perceived as successful in financial terms.

4.1. Information and methods used for evaluating CIM investments

Financial evaluation criteria

The average hurdle rate used for evaluating investments in the sample was 22.3%. The average cut-off point for the pay-back period specified was 2.5 years. A frequency distribution of the minimum required rate of return and the maximum pay-back period are given below (table 1 and 2).

Hurdle rate	% respondents *
≤ 15%	37.5
15% - 30%	50.0
≥ 30%	12.5
n.a. (confidential)	0.0

* includes only those respondents who reported that a hurdle rate was specified, which represents about 21% of the total number of respondents

Table 1: Frequency distribution of hurdle rate (minimum required rate of return)

Max. pay-back period	% respondents *
≤ 1 year	10.0
> 1 - 2 years	40.0
> 2 - 3 years	40.0
> 3 years	10.0
n.a. (confidential)	0.0

* includes only those respondents who reported that a max. pay-back period was specified, which represents about 26% of the total number of respondents

Table 2: Frequency distribution of maximum pay-back period

About 8% of the respondents specified a minimum required rate of return as the single financial criterion used for investment evaluation, whereas approximately 13% set an upper limit on the pay-back period but did not use any hurdle rate to delineate what constituted acceptable investment proposals. Thirteen percent of the companies specified cut-off levels for both criteria. It is interesting to note, however, that a fairly large number (66%) of the companies did not specify either an explicit minimum acceptable rate of return or a pay-back criterion. A possible explanation may be that in many companies people implicitly know when a financial return is acceptable to top management and when it is not, even though it has never been formalized in a standard rule.

The hurdle rate applied to investments in CIM technologies was higher than for other investments in 20% of the cases. This indicates a tendency to incorporate a higher risk premium for CIM investments in the investment evaluation.

It is interesting to compare the preset hurdle rate and pay-back period to the calculated *ex ante* internal return of return or pay-back period for the investment in CIM technology (frequency table 3 and 4). The average expected IRR[2] of 23.4% is only slightly higher than the average hurdle rate (22.3%); the median equals 25%. The average expected pay-back period is 3.3 years, which exceeds the average maximum pay-back period of 2.5 years. We note that in 38% of the companies where the expected IRR and/or pay-back period of the CIM investment were calculated, no formal criteria for these financial measures were specified.

[2] The computation of the average calculated IRR excluded one outlier in the sample: a reported IRR of 260%.

Expected IRR	% respondents *
≤ 15%	15.4
15% - 30%	46.2
≥ 30%	15.4
n.a. (confidential)	23.0

* includes only those respondents who reported that the expected IRR was calculated, which represents about 34% of the total number of respondents

Table 3: Frequency distribution of expected IRR for CIM investment

Expected pay-back period	% respondents *
≤ 1 year	4.8
> 1 - 2 years	23.8
> 2 - 3 years	38.1
> 3 years	23.8
n.a. (confidential)	9.5

* includes only those respondents who reported that the expected pay-back period was calculated, which represents about 55% of the total number of respondents

Table 4: Frequency distribution of expected pay-back period for CIM investment

Of the projects that were considered by the concerned companies to be major investments, 70% were subjected to a financial evaluation, compared to 59% for the projects of a smaller size and scope. This raises doubts about the claim that major CIM investments can only be justified based on faith.

Although more than 60% of the companies answered that top management's go/no-go decision for investments in general was based on the expected financial return and that they strictly treated the required minimum rate of return or maximum pay-back period as a pass/fail hurdle, more than 75% admitted to use these financial criteria rather loosely when evaluating strategic investments. That is, an investment whose expected return did not meet the preset requirements could still be accepted for "strategic" reasons. The latter was found to be true in companies that had a strong engineering

orientation; that were characterized by strong goal congruence[3]; where top management had a clear long-term strategic vision; and where top management had a strong interest in new technology. We did not find any evidence that strategic issues would dominate the investment decision making as the level of integration of the CIM system increased (cfr. Meredith and Hill (1987)).

Other aspects which played a significant role in the decision to acquire CIM technology when the expected financial return did not meet the minimum requirement are listed in table 5, in decreasing order of importance. Strategic considerations, especially the investment's fit with the competitive strategy pursued by the company, appeared to have the biggest weight in the decision to go ahead with the project despite the low *ex ante* calculated return.

Other key elements in the decision making	Average score *
The fact that the investment fits with the firm's well-defined competitive strategy	5.9
Long-term strategic vision of top management	5.3
Fact that there was a committed project champion	4.1
Technological know-how of top management	3.9
Pressure to stay in business	3.6
Availability of grants	2.2

* includes only those investments whose expected return did not meet the minimum requirements, which represents about one third of the total number of respondents

Table 5: Elements other than the expected financial return that played an important role in the investment decision about CIM technology

It is interesting to note the important influence of a committed project champion on the investment decision process. This provides some evidence to support the contention that the project champion is appraised as much as the investment itself. It followed from our data that strategic issues may indeed compensate for an uncertain financial return in the investment evaluation when the project is being pushed forward by a strong "believer". About 73% of the respondents in our sample emphasized the

[3] An organization with strong goal congruence was operationalized as one whose members share a set of common values and are striving to achieve the same goals. This item was included in the questionnaire because it has been suggested in the literature that getting "all noses pointed in the same direction" constitutes a powerful orgaizational control mechanism which may reduce the need for formal financial controls [e.g. Ouchi (1979)].

championing role of the project leader. An even larger number (78%) mentioned active support for the project from one or more sponsors at top management level.

Cash-flow scenario

In nearly 60% of the cases a most likely cash-flow scenario was used in the financial justification of the CIM investment. Two-thirds of the respondents reported that the "base case" assumptions underlying the calculation of the investment's expected return related to the cost structure. This indicates that the majority of the investments in CIM technologies were justified based on expected cost savings rather than increased income. Fourty percent of the respondents assumed that the cost structure would remain unchanged if the CIM investment was not undertaken.

It is also interesting to note that 38% of the respondents admitted there was a tendency to introduce an overly optimistic bias in the cash-flow estimates in order to get an investment project approved by top management.

Risk analysis

The companies in the sample used a variety of techniques to account for the risk and uncertainty associated with their CIM investment (table 6). However, a fairly large fraction appeared not to use any formal method for incorporating the risk element into the investment appraisal.

Method used for risk analysis	% respondents
Risk was not taken into account	45.2
Shortening required pay-back period	16.7
Sensitivity analysis	9.5
Increasing required hurdle rate	7.1
Subjective adjustment of cash-flows	7.1
Comparative analysis at different cash-flow scenarios	7.1
Probability analysis (simulation)	0.0
Other	7.2

Table 6: Methods used for risk analysis in evaluating CIM investments

About one fifth of the proposed investments was sent back for revision by top management. Reducing capital expenditures by shrinking the project and/or looking for a less expensive technical alternative were the most common modifications made to get the project accepted.

4.2. Impact of accounting control systems and organizational characteristics on investment decisions about CIM technologies

Formal capital budgeting procedures

The vast majority (about 80%) of the companies used standard capital budgeting procedures, such as a Capital Authorization Request.

The formal capital budgeting procedures appeared to have a negative effect on the duration of the project in some instances. The time that elapsed between the generation of the investment idea and the final decision was about 40 weeks on average, but with a fairly big spread. The respondents answered that the project was protracted in 43% of the cases and indicated the complex procedures for obtaining investment approval as the primary cause of the delay.

The extent to which responsibility for capital investment decisions was delegated to divisional managers is shown in table 7. The results indicate that in more than half of the companies divisional managers are allowed to decide autonomously about individual investments up to a certain capital expenditure limit, above which approval from higher management levels is required.

Responsibility for capital expenditures	% respondents *
Ceiling on capital expenditure for individual projects	57.2
Approval from corporate headquarters required for all capital investments	40.0
Divisional managers allowed to spend within the limits of their budgets; no limit for individual projects	2.8
Divisional managers can spend without restriction, provided they can find the necessary funds	0.0

* includes only those companies which have a divisional structure, which represents about 83% of the total number of respondents

Table 7: Responsibility for capital investment decisions delegated to divisional managers

Approximately 43% of the companies reported that the proposal for the CIM investment had emanated as a local initiative and was subjected to formal approval by top management . An almost equal number of respondents described the investment as being primarily top-down mandated as a corporate policy, while lower levels in the organization participated to some extent in the decision making. In 12% of the cases the final authorization by top management was seen as a mere formality because the investment proposal had gained support from a large part of the organization as it progressed up in the management hierarchy (cfr. Bower (1970)).

Performance measurement

Table 8 shows' the extent to which post-implementation audits of investments were performed by the survey respondents.

Post audit of capital investments	% respondents
Post audit is done for some investments	40.0
No post completion audit is done	32.5
Post audit is done for all investments	22.5
Other	5.0

Table 8: Use of post-implementation audit for capital investments

We found no evidence in our study that the use of post audits might reduce the propensity to introduce an optimistic bias in the cash-flow estimates to get an investment approved.

It followed from the survey results that more than half of the companies emphasized both strategic performance measures (e.g. flexibility, delivery lead time, etc.) and short-term financial measures to evaluate the performance of plant management.

Integration of capital budgeting with the company goals and strategies

The investment budget was considered to be the most important control mechanism devised to ensure that investment projects are in line with the corporate goals and strategies (table 9). This is consistent with the findings from a previous empirical study by Scapens and Sale (1981).

Planning and control mechanisms used	% respondents *
Control is exercised through investment budgets	61.9
Corporate headquarters issue broad guidlines and each division produces its own capital investment plan	35.7
Investment goals are stated in long-term plans prepared by corporate headquarters and communicated to the divisions	16.7

* includes only those companies which have a divisional structure, which represents about 83% of the total number of respondents

Table 9: Control mechanisms used to integrate divisional projects with corporate objectives

Relationships between characteristics of the capital budgeting process and ex post performance

Respondents were asked to assess the investment's *ex post* financial performance in terms of its contribution (positive or negative) to the profitability of the plant or the profit center to which the plant belongs. Table 10 summarizes the elements that were perceived as having contributed to the success of the project.

Factors underlying the investment's high performance	Average score *
CIM technology has been introduced to eliminate a bottleneck in the process	4.5
Investment fits with the firm's competitive strategy	4.4
Long-term strategic vision of top management	4.3
Committed project champion	4.1
Strong commitment of top management	4.0
Company culture is favorable to new technology	3.5
In-house technological expertise	3.4
Performance measures used to evaluate plant management	3.1
Technological know-how of top management	2.8
High requirement with regard to the hurdle rate	2.3

* includes only those investments that made a positive contribution to plant profitability and were already implemented, which represents about 74% of the total number of projects

Table 10: Factors perceived as having contributed to the success of the investment

Table 10 clearly demonstrates the critical importance of the fit between the investment and the company strategy. The strategic factors that led to the initiation of the investment in CIM technology are listed in table 11 .

Driving forces that triggered the CIM investment	Average score
Pressure to increase internal productivity and efficiency	5.5
Increasing competitive pressure on costs	4.9
New trends in customer demand: increasing diversity and product customization, smaller quantities	4.2
Time-based competition	4.0
Pressure for implementing JIT	3.7
Increasing product complexity	3.6
It was the next step in the company's technology strategy	3.6
Strategy of product differentiation	3.4
Need to replace obsolete production equipment	3.2
General interest in new technology	3.1
New manufacturing technology became available	3.1
Desire to learn about CIM technology	3.0
Products not designed for manufacturability	2.4
Competitors invested in CIM technology	2.3

Table 11: Strategic factors that triggered the investment in CIM technology

It is interesting to note that productivity and cost considerations are the primary drivers of CIM investments and that the frequently cited argument that "we have to invest because our competitors are doing it" figures at the bottom of the list. CIM investments for which technology was one of the important driving factors were usually found in companies whose top management had a strong interest in new technology and a clear view of the potential benefits they could offer.

We also note the importance of a committed project champion to the success of a CIM investment.

It is often argued that the quality of the strategic analysis is a critical success factor in the decision making about investments in CIM technologies [Slagmulder and Bruggeman (1992)]. In the sample firms we found a relatively high degree of consistency between the strategic considerations that led to the CIM investment and the competitive priorities pursued by the firm. A qualitative analysis of the data indeed showed that, for instance, CIM investments were initiated because of increasing product diversity and complexity in the context of a competitive strategy which emphasized product flexibility (ability to make rapid design changes, to introduce new products quickly, mix-flexibility, etc.). Time and efficiency related investments were most often found in companies that pursued delivery performance as a competitive priority.

Table 12 shows the factors, in decreasing order of importance, that were perceived as potential causes of low performance for those projects that had a negative effect on plant profitability.

It follows from the above table 12 that the primary reason why an investment was perceived as having negatively contributed to the plant profitability was due to an underestimation of certain costs. These costs related to training of workers, internal engineering, consulting, start-up, maintenance, and software development.

The performance measurement system was also reported as a factor that might prevent an investment from being successful. This validates the claim that companies' use of short-term performance measures leads to dysfunctional effects. There was no significant difference, however, in the use of financial versus strategic performance measures between the companies with successful and those with unsuccessful investments. This may lead us to conclude that the negative effect of the performance measurement system relates to the emphasis on short-term operational measures. One could easily imagine a flexible manufacturing system whose output does not live up to the expectations because it is used in a mass production mode instead of in a flexible regime, under the pressure of a performance measurement system which puts too much emphasis on productivity and efficiency.

Factors underlying the investment's low performance	Average score *
Certain expenses have been overlooked or underestimated	5.6
Certain benefits have been overestimated	3.8
Company culture is unfavorable to new technology	2.6
Lack of long-term strategic vision of top management	2.4
Lack of in-house technological expertise	2.1
Performance measures used to evaluate plant management	2.1
Lack of technological know-how of top management	2.0
The investment's expected financial return did not meet the minimum requirements	1.9
Lack of a committed project champion	1.8
Investment did not fit with the firm's competitive strategy	1.7
Lack of commitment of top management	1.6

* includes only those investments that made a negative contribution to plant profitability and were already implemented, which represents about 21% of the total number of projects

Table 12: Factors that had a negative effect on the investment's performance

Finally, we note that we did not find any relationship between the use of financial evaluation methods, such as IRR and pay-back period, and the *ex post* performance of the investment.

5. DISCUSSION

As a general conclusion from this empirical study we could state that strategic issues dominated the decision making about investments in CIM technologies. Although many CIM investments were initiated with the purpose of reducing costs and/or increasing productivity, qualitative considerations, such as fit with the company strategy and the support of a committed project champion, appeared to have a significant positive impact on the investment decision. The capital budget and capital expenditure limits at different hierarchical levels were among the traditional accounting-based control systems most frequently used to guide the investment decision process. The overstatement of the expected cost savings was highlighted as one of the main problem areas.

This empirical study was intended to be exploratory in the first place. This implies that we just touched on a number of interesting topics which relate to strategic investments in CIM technologies. In this final section we want to hightlight some fruitful research areas that still remain to be further explored.

First, the capital budgeting literature with regard to CIM investments focuses primarily on the investment evaluation problem, more precisely on whether strategic or financial considerations should play the key role in the decision. In general, there seems to be an implicit agreement that good investment decision making is synonymous with good evaluation. This may explain why the efforts of the academic community have to a great extent been devoted to the development of more sophisticated quantitative models for project appraisal, in particularly in the CIM area.

Most of the literature and research, however, has failed to include the other stages in the capital budgeting process. It should be emphasized that capital budgeting is a multi-stage organizational process involving identification of investment opportunities, development of project proposals, investment evaluation, and post-implementation control. Focusing exclusively on the investment justification problem without considering its interface with the other phases is myopic because one inevitably overlooks some of the essential features of the overall capital budgeting process.

Second, it has been argued that the formal capital budgeting system employed by many companies to keep the investment process under control, including the use of standard methods such as DCF, may embrace only part of the investment decision process [King (1975)]. Little attention has been devoted to how capital budgeting decisions are actually made in organizations. Part of this is due to the extensive use of surveys in the capital budgeting area which fail to probe sufficiently deep into organizational reality. There are a few field studies available which describe in detail the processual aspects of capital investment decision making [e.g. Bower (1970)]. These findings show that a more complex decision process is taking place in practice than is suggested by the normative capital budgeting literature.

The question then arises what is the role of the standard capital budgeting methods and procedures in the investment decision process for CIM-related technologies. This entails an inquiry on the relevance of the financial calculations in the investment justification phase as well as on the role of the formal systems for transmitting investment proposals from lower levels in the organization to top management for approval. This survey research has made a first attempt to shed some light on the matter, but much more in-depth field research, based on interviews with multiple key informants in each company, is necessary to unravel the relative impact of various organizational control mechanisms on strategic investment decision processes.

Third, few research in the area of capital budgeting has addressed the strategic aspects of capital budgeting, despite the fact that the problem has repeatedly been mentioned in the literature [e.g. Pinches (1982)]. We believe that significant progress could be made by examining how well-managed organizations align their resource allocation process with their long-term goals and strategies. Further empirical research is required to investigate the relationships between investment decision making and the process of strategy formation and strategic planning. Advances in this area would do much to enrich our understanding of capital budgeting practice, in particular for strategic investments in CIM technology, as these investments are usually initiated in response to some opportunity to create long-term value for the firm.

Finally, further empirical research should allow us to better explain the differences in capital budgeting processes observed in practice. Based on our exploratory research we carefully hypothesize that there is probably no single solution to the question which approach to capital budgeting is most appropriate for strategic investment decision making about CIM technologies, because the answer is most likely to be dependent on a number of contextual variables. This implies that different modes of investment decision making can lead to successful investments in CIM, but each way may not be equally effective under all conditions. As a consequence, the relevant characteristics of the capital budgeting process on the one hand, and the investment context on the other hand will have to be identified and analyzed, as well as how their interaction affects the *ex post* financial performance.

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APPENDIX: QUESTIONNAIRE

1. Characteristics of the Investment Project Context

1.1. On the scales below, how would you assess the market targeted by this investment in CIM technology?

	Declining			*Stable*			*Growing*
Market trend:	1	2	3	4	5	6	7
	Totally unpredictable						*Totally predictable*
Predictability of market demand:	1	2	3	4	5	6	7
	Extremely short						*Long and stable*
Product life cycles:	1	2	3	4	5	6	7
	Not profitable						*Very profitable*
Profitability of the industry:	1	2	3	4	5	6	7
	Very turbulent						*Very stable*
Stability of the industry:	1	2	3	4	5	6	7
	Very low						*Very high*
Number of competitors in the industry:	1	2	3	4	5	6	7
	Very low						*Very fierce competition*
Rivalry among competitors in the industry:	1	2	3	4	5	6	7

1.2. What is the plant's market share?

Plant has _____ % market share.

	Declining			*Stable*			*Growing*
Evolution of the plant's market share:	1	2	3	4	5	6	7

1.3. How would you score the profitability of the plant relative to the industry average?

	Very low						*Very high*
Profitability of the plant compared to most of its competitors in the same industry:	1	2	3	4	5	6	7

1.4. In general, what are the competitive strengths pursued by the plant? (Indicate all that apply)

	Not important						*Very important*
Ability to make profits in price competitive markets	1	2	3	4	5	6	7
Ability to make rapid design changes	1	2	3	4	5	6	7
Ability to introduce new products quickly	1	2	3	4	5	6	7
Ability to make rapid volume changes	1	2	3	4	5	6	7
Ability to make rapid product mix changes	1	2	3	4	5	6	7
Ability to offer a broad product line	1	2	3	4	5	6	7
Ability to offer consistent quality with low defects	1	2	3	4	5	6	7
Ability to provide fast deliveries to customers	1	2	3	4	5	6	7
Ability to make dependable delivery promises	1	2	3	4	5	6	7
Ability to customize products/ services to customer needs	1	2	3	4	5	6	7
Ability to provide effective customer service	1	2	3	4	5	6	7
Other:_____	1	2	3	4	5	6	7

1.5. How would you characterize the production of the products targeted by this particular investment in terms of end product variety and average lot size, if applicable?

Number of different end products:	☐ 1-10	☐ 10-100	☐ > 100	☐ Not applic.
Average lot size:	☐ 1-10	☐ 10-100	☐ > 100	☐ Not applic.

1.6. Indicate on the scale below to what extent you agree with each of the following statements about the organization and its management:

(1 = strongly agree, 2 = agree, 3 = somewhat agree, 4 = undecided, 5 = somewhat disagree, 6 = disagree, 7 = strongly disagree)

	Strongly agree						*Strongly disagree*
The plant has a strong engineering orientation and there is a lot of in-house expertise in CIM technology	1	2	3	4	5	6	7
The organization is characterized by strong "goal congruence" (all members share the same values and are striving for the same goal)	1	2	3	4	5	6	7
The organization was ready to accomplish the project successfully: the project team had built up experience with similar projects and was familiar with the technology, and there were sufficient resources available	1	2	3	4	5	6	7
The organization was ready to use the new technology successfully: the existing operational (systems, skills) and cultural environment were favorable to the new technology	1	2	3	4	5	6	7
Top management has a clear long term vision of the company's manufacturing and technology strategy as well as the plant's competitive advantage	1	2	3	4	5	6	7
Top management has a strong interest in new technology and is able to judge its potential benefits for the plant	1	2	3	4	5	6	7
The manager who was the major driving force behind the investment project under consideration, was owner or shareholder of the company	1	2	3	4	5	6	7

1.7. Indicate on the scale below to what extent you agree with each of the following statements about the project management of this particular investment:

(1 = strongly agree, 2 = agree, 3 = somewhat agree, 4 = undecided, 5 = somewhat disagree, 6 = disagree, 7 = strongly disagree)

	Strongly agree						*Strongly disagree*
The project leader was a competent person in terms of technological know-how, planning, leadership and negotiation skills, and he had enough authority to make important decisions at critical points	1	2	3	4	5	6	7
The project leader was able to realize open communication and consensus between all parties involved in the system implementation (project team, supplier(s), consultants, subcontractors, potential users)	1	2	3	4	5	6	7
The project leader was a real "believer" or "champion" who was strongly committed to making the system work	1	2	3	4	5	6	7
There was active commitment and support from one or more "sponsors" on top management level, who pushed the investment project and were able to provide the necessary funds	1	2	3	4	5	6	7

1.8. If the company has a divisional structure, please score on the scales below the extent of divisional autonomy of the plant where the investment was undertaken:

☐ Not applicable (company does not have a divisional structure)

	Strongly centralized						*Strongly decentralized*
Degree of decentralization in terms of: the number of centralized functions provided by corporate headquarters, number of interdependencies between divisions	1	2	3	4	5	6	7

	Very limited autonomy						*Complete autonomy*
Capital investment autonomy (delegated authority over capital expenditure decisions) of the plant manager	1	2	3	4	5	6	7

1.9. If the company has a divisional structure, please specify to what extent responsibility for capital investment decisions has been delegated to divisional managers:

☐ All capital investment requires approval from corporate headquarters

☐ Divisional managers are allowed to spend on individual projects up to a certain limit
If so, what is the capital expenditure ceiling on individual projects for the plant (in ECU)?
_____ ECU

☐ Divisional managers are allowed to spend amounts within the limits of their budgets, but there is no limit for individual projects

☐ Divisional managers can invest without restriction, provided they can obtain the necessary funds

☐ Other: _____

☐ Not applicable (company does not have a divisional structure)

1.10. If the company has a divisional structure, which control mechanisms are used to ensure that divisional projects are in line with corporate objectives? (Indicate all that apply)

☐ Investment goals are stated in long-term corporate plans prepared by corporate headquarters and are communicated to the divisions

☐ Corporate headquarters issue broad guidelines and each division produces its own long-term capital investment plan

☐ Control is exercised through investment budgets

☐ Other: _____

☐ Not applicable (company does not have a divisional structure)

1.11. If the company has a divisional structure, Indicate to what extent the responsibility for the preparation of investment budgets has been delegated to the divisional manager. Please use the following rating:

Low score = responsibility is at the corporate level,
Medium score = interaction between division and corporate headquarters (e.g. budgets are prepared by divisional managers and subject to approval of headquarters),
High score = responsibility is at the divisional level

☐ Not applicable (company does not have a divisional structure)

	Responsibility at corp. level			*Inter-action*			*Responsibility at divis. level*
Extent to which plant manager has responsibility for the preparation of the investment budget	1	2	3	4	5	6	7

1.12. Does the company undertake ex post monitoring of capital investment decisions?

- ☐ No post completion audit is done
- ☐ Post completion audit is done for some investment projects

  If so, for which projects? _____

- ☐ Post completion audit is done for each investment project
- ☐ Other: _____

1.13. What kind of performance measurement system is used to evaluate plant management? (Indicate all that apply)

	Not important						*Very important*
Short term financial performance	1	2	3	4	5	6	7
Strategic performance (e.g. flexibility, delivery lead time, ...)	1	2	3	4	5	6	7
Other: _____	1	2	3	4	5	6	7

1.14. Which financial criteria are used to evaluate the performance of plant management? (Indicate all that apply)

	Not important						*Very important*
ROI (Return On Investment)	1	2	3	4	5	6	7
Profit of the year after charging interest on total capital employed by the plant	1	2	3	4	5	6	7
Profit of the year before interest and taxes	1	2	3	4	5	6	7
Cash-flow	1	2	3	4	5	6	7
Variance between actual costs and standard costs	1	2	3	4	5	6	7
Other: _____	1	2	3	4	5	6	7

2. Description of the Investment Project and its Purpose

2.1. Which type of CIM technology is the particular investment under consideration about?

- ☐ CAD (Computer Aided Design) / CAE (Computer Aided Engineering)
- ☐ CNC-machine
- ☐ Robot
- ☐ CAM (Computer Aided Manufacturing)
- ☐ FMS (Flexible Manufacturing System) / FAS (Flexible Assembly System)
- ☐ Linked CAD/ CAM
- ☐ CAPP (Computer Aided Process Planning)
- ☐ AS/ RS (Automated Storage and Retrieval System)
- ☐ Automated materials handling
- ☐ Other: _____

Please describe briefly this technology and its intended use:

_____

_____

_____

2.2. Specify the level of technological integration of the system described above:

- ☐ Stand-alone or unitary equipment
- ☐ Cellular grouping of equipment and tools for the production of families of parts
- ☐ System that links together different pieces of a functional area or separate functional areas
- ☐ Fully integrated system
- ☐ Other: _____

2.3. Indicate on the scale below to which extent you agree with each of the following statements:

(1 = strongly agree, 2 = agree, 3 = somewhat agree, 4 = undecided, 5 = somewhat disagree, 6 = disagree, 7 = strongly disagree)

	Strongly agree						*Strongly disagree*
The technology introduced was "leading edge": it was new to the industry and its potential benefits were not yet proven	1	2	3	4	5	6	7
The technology was completely new to the plant and to the company to which the plant belongs	1	2	3	4	5	6	7
The technology was completely new to the plant, but not to the company to which the plant belongs, so there was ample opportunity to learn from the experience gained in other plants of the group	1	2	3	4	5	6	7
The investment was perceived as a risky project in the sense that there was great uncertainty with respect to the outcome of the project	1	2	3	4	5	6	7
The introduction of this new system caused major changes in the goods flow, so modification of the factory layout was necessary	1	2	3	4	5	6	7
The introduction of this new system had a major impact on the production organization (in terms of: more cross-functional integration, increased number of shifts, increased complexity of the production planning, shift in job content of operators, ...)	1	2	3	4	5	6	7

2.4. How does the size (in terms of capital investment, costs, number of people involved) and the degree of difficulty of this investment project compare to other investments which have been implemented in the plant in the past?

	Very small						*Extremely big/ costly*
Relative size of the project:	1	2	3	4	5	6	7
	Very easy						*Extremely difficult*
Relative complexity of the project:	1	2	3	4	5	6	7

2.5. Please indicate on the scale below the scope of the investment project:

Low score = Project was part of a coordinated series of smaller incremental investments
High score = Project was a "big leap"

	Incremental						*Big leap*
Scope of the investment:	1	2	3	4	5	6	7

2.6. Please indicate on the scale below to what extent the investment implied building new facilities:

Low score = New system was an update of the existing equipment and was inserted into the existing production process
High score = Greenfield implementation (completely new facility was built)

	Update						*Greenfield*
Introduction of the new system was:	1	2	3	4	5	6	7

2.7. Which was/ were the driving force(s) that triggered this investment project in CIM technology? (Indicate all that apply)

	Not important						*Very important*
New trends in market/ customer demand: increasing diversity and product customization, smaller quantities	1	2	3	4	5	6	7
Increasing product complexity	1	2	3	4	5	6	7
Strategy of product differentiation	1	2	3	4	5	6	7
Product(s) not designed for manufacture	1	2	3	4	5	6	7
Time-based competition	1	2	3	4	5	6	7
Increasing competitive pressure on costs	1	2	3	4	5	6	7
Pressure for implementing Just-In-Time	1	2	3	4	5	6	7
Pressure for increasing internal productivity/ efficiency	1	2	3	4	5	6	7
Competitors invested in CIM technology	1	2	3	4	5	6	7
New manufacturing technology became available	1	2	3	4	5	6	7
Need to replace obsolete production equipment	1	2	3	4	5	6	7
Desire to learn about CIM technology	1	2	3	4	5	6	7
General interest in new technology	1	2	3	4	5	6	7
It was the next step in the company's well-defined technology development strategy	1	2	3	4	5	6	7
Other:_____	1	2	3	4	5	6	7

2.8. When considering this investment, which were important objectives relating to the company's sustainable competitive strategy?

	Not important						*Very important*
Marketing objectives							
Defend market share/ stay in business	1	2	3	4	5	6	7
Build market share with existing or new products	1	2	3	4	5	6	7
Create new markets for new products	1	2	3	4	5	6	7
Other:_____	1	2	3	4	5	6	7

	Not important						*Very important*
Objectives for manufacturing							
Increase ability to customize products to customer needs	1	2	3	4	5	6	7
Increase ability to produce "difficult" products	1	2	3	4	5	6	7
Extend range of products that can be produced	1	2	3	4	5	6	7
Increase ability to offer a broad product line	1	2	3	4	5	6	7
Increase ability to make rapid product mix changes	1	2	3	4	5	6	7
Increase speed of new product development	1	2	3	4	5	6	7
Reduce time-to-market for new products	1	2	3	4	5	6	7
Reduce costs of new product introduction	1	2	3	4	5	6	7
Increase speed of design changes to existing products	1	2	3	4	5	6	7
Reduce costs in product design	1	2	3	4	5	6	7
Reduce manufacturing lead times	1	2	3	4	5	6	7
Reduce machine setup and change-over times	1	2	3	4	5	6	7
Increase delivery speed to customers	1	2	3	4	5	6	7
Improve due-date delivery performance	1	2	3	4	5	6	7
Increase ability to handle rush orders efficiently	1	2	3	4	5	6	7
Increase ability to make rapid volume changes	1	2	3	4	5	6	7
Increase ability to handle small lot sizes efficiently	1	2	3	4	5	6	7
Reduce manufacturing costs	1	2	3	4	5	6	7
Reduce material inventory	1	2	3	4	5	6	7
Reduce WIP inventory	1	2	3	4	5	6	7
Reduce finished goods inventory	1	2	3	4	5	6	7
Reduce scrap/ rework	1	2	3	4	5	6	7
Reduce floor space requirements	1	2	3	4	5	6	7
Increase throughput/ production volume	1	2	3	4	5	6	7
Increase capacity utilization	1	2	3	4	5	6	7
Improve quality in terms of internal defect rates	1	2	3	4	5	6	7
Increase ability to produce to tighter tolerances	1	2	3	4	5	6	7

Improve company image of quality and professionalism	1	2	3	4	5	6	7
Nurture learning about CIM technology	1	2	3	4	5	6	7
Create or maintain technological leadership	1	2	3	4	5	6	7
Other:_____	1	2	3	4	5	6	7

2.9. Who within the organization had the primary responsibility for the investment decision about this project? Please describe the actual decision process rather than the formal procedures.

- ☐ The investment proposal was conceived and initiated at a lower level in the organization and was gradually passed on upwards by an individual manager, thereby gaining support from a large section of the organization. The final authorisation by top management was in fact no more than a formality.
- ☐ The investment proposal has emanated as a local initiative at a lower level in the organization, but was subject to the formal approval of top management who could reject the project.
- ☐ The investment was top-down mandated as a corporate policy, the investment opportunity was identified and the investment proposal initiated by top management. Lower levels in the organization were to some extent involved in the decision making about this project.
- ☐ The investment was top-down mandated as a corporate policy, the investment opportunity was identified and the investment proposal initiated by top management. Lower levels in the organization were not involved in the decision making about this project.
- ☐ Other:_____

2.10. How fast did the investment decision making process proceed?

The time that has elapsed between the generation of the investment idea and the final decision was: _____ weeks

2.11. If the decision making for this investment project was protracted, what was the main reason? (Indicate all that apply)

- ☐ Not applicable (investment decision was not protracted)

	Not important						*Very important*
Shortage of funds	1	2	3	4	5	6	7
Complex organizational procedures for obtaining capital investment approval	1	2	3	4	5	6	7
Project was interrupted and revised several times because intermediate project audits showed unfavorable result	1	2	3	4	5	6	7
Other:_____	1	2	3	4	5	6	7

2.12. Who was involved in the implementation of the new system?

- ☐ Implementation entirely done by the supplier(s)/ Turn-key contract
- ☐ Implementation in co-makership with the supplier
- ☐ Implementation entirely done by in-house engineering staff
- ☐ Other:_____

2.13. Please explain briefly why you have chosen this particular investment project for the survey:

_____

_____

_____

2.14. Indicate how representative the investment project under consideration is in terms of overall success/ failure compared to other investments in manufacturing technology which have been undertaken in the past?

- ☐ Most of our investments in manufacturing technology have been successful and this project is one of them
- ☐ Most of our investments in manufacturing technology have been partially successful and this project is one of them
- ☐ Most of our investments in manufacturing technology have been complete failures and this project is one of them
- ☐ Most of our investments in manufacturing technology have been successful, but this project is an exception in the sense that it is performing worse than the rest
- ☐ Most of our investments in manufacturing technology have been partially successful, but this project is an exception in the sense that it is performing better than the rest
- ☐ Most of our investments in manufacturing technology have been partially successful, but this project is an exception in the sense that it is performing worse than the rest
- ☐ Most of our investments in manufacturing technology have been complete failures, but this project is an exception in the sense that it is performing better than the rest
- ☐ Other: _____

3. Financial Justification

3.1. Indicate on the scale below to what extent you agree with the each of the following statements corresponding to the company's capital budgeting policy in general:

(1 = strongly agree, 2 = agree, 3 = somewhat agree, 4 = undecided, 5 = somewhat disagree, 6 = disagree, 7 = strongly disagree)

	Strongly agree						*Strongly disagree*
For every investment proposal there are standard procedures (e.g. Capital Authorization Request) to be followed in order to obtain top management's approval	1	2	3	4	5	6	7
Top management's go/ no go decision is based on the expected financial return of the investment and the required minimum return or maximum pay-back is strictly treated as a pass/ fail hurdle	1	2	3	4	5	6	7
Top management requires a short pay-back period for every investment project because the company might otherwise get into liquidity problems	1	2	3	4	5	6	7
An investment project whose expected return falls below the required level can still be accepted for strategic reasons	1	2	3	4	5	6	7
In most cases top management pays no attention to the outcome of the financial analysis	1	2	3	4	5	6	7
The same financial target (required return) is used for all investments in the company	1	2	3	4	5	6	7
The required return is adjusted depending on the type of investment project	1	2	3	4	5	6	7
The hurdle rate applied for investments in CIM technology is higher than for other investments	1	2	3	4	5	6	7
When making the financial calculations, there is a tendency to introduce an overly optimistic bias in the cash-flow estimates in order to get an investment approved by top management	1	2	3	4	5	6	7

3.2. If the company has a divisional structure, to what extent was authority over this capital investment delegated to the plant manager?

☐ Not applicable (company does not have a divisional structure)

	Very limited						*Very high*
Capital investment autonomy of the plant manager (in terms of interference from corporate management) for this particular project was:	1	2	3	4	5	6	7

3.3. What was the total capital investment originally budgetted for the particular CIM project under consideration, in European Currency Units (ECU)?

Total capital outlay: _____ ECU

3.4. How did you account for the risk and uncertainty associated with this investment project?

☐ Risk has not been taken into account in the capital budgeting analysis
☐ Shortening required pay-back period
☐ Increasing required hurdle rate
☐ Subjective adjustment of estimated cash-flows
☐ Sensitivity analysis
☐ Comparative analysis at optimistic, pessimistic and most likely cash-flow scenario
☐ Probability analysis (simulation based on probability distributions of future cash-flows)
☐ Other: _____

3.5. What was the true expected return of the investment project ("true" return means: based on sincere cash-flow estimates)?

Calculated internal rate of return: _____ % ☐ Was not calculated

Calculated pay-back period: _____ years ☐ Was not calculated

Other: _____

3.6. What was the hurdle rate used for this investment?

Hurdle rate: _____ % ☐ Was not specified

Required maximum pay-back period: _____ years ☐ Was not specified

Other: _____

3.7. What is the company's cost of capital?

_____ %

3.8. The expected return of the project was mainly expected to result from: (Indicate all that apply)

☐ Increase of sales

☐ Reduction of manufacturing costs (direct labour, overhead) and inventory

☐ Other: _____

3.9. Which cash-flow scenario has received most attention in the financial justification?

☐ Worst case scenario

☐ Pessimistic scenario

☐ Most likely scenario

☐ Optimistic scenario

☐ Other: _____

3.10. What was the assumption about the base case (i.e. the evolution of future sales and cost structure if the investment is not undertaken) underlying the calculation of the expected return of this investment? (Indicate all that apply)

The assumption was: Without this investment,

☐ the cost structure will remain unchanged

☐ the cost structure will change
If so, what kind of change? _____

☐ future sales will remain unchanged

☐ future sales will go down
Reason: _____

☐ future sales will increase
Reason: _____

☐ Other: _____

3.11. If the investment proposal has been sent back by top management for revision, what modifications have been made to the proposal so that it would ultimately get top management's approval?

(1 = strongly agree, 2 = agree, 3 = somewhat agree, 4 = undecided, 5 = somewhat disagree, 6 = disagree, 7 = strongly disagree)

☐ Not applicable (proposal was not rejected)

	Strongly agree						*Strongly disagree*
The project was shrunk and the expenses were reduced to a more acceptable level	1	2	3	4	5	6	7
The assumptions underlying the cash-flow estimates were revised and positively biased in order to get a more acceptable rate of return	1	2	3	4	5	6	7
The engineers were urged to find a technical alternative that had the same functionalities as the original system, but was less expensive	1	2	3	4	5	6	7
Other:_____	1	2	3	4	5	6	7

3.12. If the (true) expected return of the project did not meet the minimum required rate of return, what other argument(s) played an important role in your decision to go ahead with the project?

☐ Not applicable (expected return met the miminum required rate of return)

	Not important						*Very important*
The fact that the investment fits with the firm's well-defined competitive strategy	1	2	3	4	5	6	7
Pressure to stay in business	1	2	3	4	5	6	7
Long term strategic vision of top management	1	2	3	4	5	6	7
Technological know-how of top management	1	2	3	4	5	6	7
The fact that there was a committed project champion	1	2	3	4	5	6	7
Availability of grants	1	2	3	4	5	6	7
Other:_____	1	2	3	4	5	6	7

3.13. To what extent was the decision to go ahead with the investment influenced by the way of financing it?

	Not important						*Very important*
Influence of way of financing on the investment decision	1	2	3	4	5	6	7
Influence of negociations with financiers	1	2	3	4	5	6	7
Influence of availability of grants	1	2	3	4	5	6	7
Other:_____	1	2	3	4	5	6	7

4. Realized Financial Performance

4.1. In what stage of implementation is the investment project at present?

- ☐ Early implementation stage ..... Implementation started in year: _____
- ☐ Implementation is well underway ..... Implementation started in year: _____
- ☐ Final implementation stage ..... Implementation started in year: _____
- ☐ Project is at an end, system is operational ..... Operational since year: _____
- ☐ Other: _____

4.2. Tick the one box which best describes the "ex post" financial performance of the investment in CIM technology in terms of its contribution to the profitability of the plant or the profit center to which the plant belongs. Please make a distinction between the realized performance at present (now) and how this performance is expected to evolve in the years to come (future).

	Now	*Future*
Investment has had a negative impact on the profitability of the plant or the profit center	☐	☐
Investment has had no impact on the profitability of the plant or the profit center	☐	☐
Without the investment project the profitability of the plant or the profit center would have decreased by less than 10%	☐	☐
Without the investment project the profitability of the plant or the profit center would have decreased by more than 10%	☐	☐

4.3. If the investment in CIM technology has positively contributed to the profitability of the plant or the profit center to which the plant belongs, which of the following elements do you think have played an important role?
For each item please also make an assessment of its impact on the investment's contribution to the profitability (in %) (e.g. a score of 60% means: the investment's positive contribution to the profitability of the plant/ profit center was by 60% due to this factor)

☐ Not applicable (investment has not positively contributed to the profitability)

	Not important						*Critically important*	*Impact (in %)*
The investment fits with the firm's well-defined competitive strategy	1	2	3	4	5	6	7	___%
The CIM technology has been introduced to eliminate a bottleneck in the process, which resulted into increased contribution output	1	2	3	4	5	6	7	___%
High requirement with respect to the hurdle rate	1	2	3	4	5	6	7	___%
Long term strategic vision of top management	1	2	3	4	5	6	7	___%
Technological know-how of top management	1	2	3	4	5	6	7	___%
Fact that top management was strongly committed	1	2	3	4	5	6	7	___%
Fact that there was a committed project champion	1	2	3	4	5	6	7	___%
In-house technological expertise	1	2	3	4	5	6	7	___%
Company culture is favorable to new technology	1	2	3	4	5	6	7	___%
Performance measures used to evaluate plant mgt.	1	2	3	4	5	6	7	___%
Other: _____	1	2	3	4	5	6	7	___%
								100 %

4.4. If the investment in CIM technology has not or has negatively contributed to the profitability of the plant or the profit center to which the plant belongs, which of the following elements do you think have played an important role?
For each item please also make an assessment of its impact on the investment's contribution to the profitability (in %) (e.g. a score of 60% means: the investment's negative or zero contribution to the profitability of the plant/ profit center was by 60% due to this factor)

☐ Not applicable (investment has positively contributed to the profitability)

	Not important						*Critically important*	*Impact (in %)*
The investment did not fit with the firm's well-defined competitive strategy	1	2	3	4	5	6	7	___%
The investment's expected financial return did not meet the minimum requirements	1	2	3	4	5	6	7	___%
Certain expenses have been overlooked or underestimated in the financial calculations	1	2	3	4	5	6	7	___%

If so, which one(s)?
- ☐ Software development
- ☐ External engineering and/or consulting
- ☐ Internal engineering and/or consulting
- ☐ Training of workers
- ☐ Start-up costs
- ☐ Maintenance costs
- ☐ Other:_____

Certain benefits have been overestimated in the financial calculations	1	2	3	4	5	6	7	___%

If so, which one(s)?
- ☐ Increase in sales
- ☐ Reduction of manufacturing costs
- ☐ Reduction of direct labour costs
- ☐ Reduction of overhead in manufacturing
- ☐ Reduction of material inventory
- ☐ Reduction of WIP
- ☐ Reduction of finished goods inventory
- ☐ Other:_____

Lack of long term strategic vision of top management	1	2	3	4	5	6	7	___%
Lack of technological know-how of top management	1	2	3	4	5	6	7	___%
Lack of commitment of top management	1	2	3	4	5	6	7	___%
Lack of commitment of the project champion	1	2	3	4	5	6	7	___%
Lack of in-house technological expertise	1	2	3	4	5	6	7	___%
Company culture is unfavorable to new technology	1	2	3	4	5	6	7	___%
Performance measures used to evaluate plant mgt.	1	2	3	4	5	6	7	___%
Other:_____	1	2	3	4	5	6	7	___%
								100 %

4.5. On the scale below please make an assessment of the overall success/ failure of this investment, at present (now) and for the years to come (future).

Success/ failure is measured as the realized performance relative to the expected performance, with the expected performance set equal to an index 100 (e.g. a score of 80 means that only 80% of the expected performance has actually been realized, whereas a score of 120 means that the realized performance exceeds the expectations by 20%).

	Now	*Future*
Realized versus expected performance (with expected performance = 100):	_____	_____

About the survey ...

Which person(s) in the company have been involved in filling out this questionnaire? (Indicate all that apply)

- ☐ General manager
- ☐ Plant manager
- ☐ Production manager
- ☐ CIM manager
- ☐ Financial controller
- ☐ Project manager of this particular investment project
- ☐ Other: _____

At some later date, would you be prepared to fill out the same questionnaire for another major investment project in CIM technology which has been undertaken in your company?

- ☐ Yes
- ☐ No

  Reason: _____

If you would like to make additional comments on any of the subjects covered in this study about the investment justification of CIM technology, please use the space below. We are very much interested in your suggestions and/ or critique on this topic:

_____

_____

_____

_____

_____