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Quality of postimplementation review for enterprise resource planning systems

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Abstract

This paper examines the process of system review during the postimplementation stage of an enterprise resource planning (ERP) system, or postimplementation review (PIR), and identifies factors that contribute to high-quality PIRs. The present study utilizes an exploratory, qualitative research approach in examining the concept of PIR and its potential importance in successful ERP system implementations. A case study methodology was employed that allowed detailed examination of significant events after the implementation of ERP systems in two different organizations. Insights from the case studies were subsequently used to conceptually define the construct of PIR quality, distinguish the construct from antecedent conditions during the implementation process and from potential outcomes, and propose a research model that could be useful in future empirical investigations. Past research efforts that addressed the extent to which organizations realize expected benefits from ERP system implementations could use this construct to reexamine performance relationships and more completely interpret their results (or lack of results) according to the extent to which organizations engage in high-quality PIRs. This study, therefore, presents contributions for both the practice and research on ERP system implementation effectiveness.

Keywords: Enterprise resource planning systems; Postimplementation review; ERP system effectiveness

> Every scientific inquiry is thought to aim at some good; some goods are means to ends, some are ends in themselves; systematic inquiry is evaluated according to the comprehensiveness of the ends it leads; excellence in human action is no result of habit, but exercise of virtue at a high level of quality is due to an informed and systematic reasoning process. (Aristotle, *Nicomachean Ethics A*).

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1. Introduction

Information systems (IS) development has been conceptualized in past research as a process that leads to a decision about the choice, design, and development of an information system (e.g., Nicolaou, 1999). Past research findings suggest that the effectiveness or success of an information system depends on a variety of factors, most importantly those relating to the extent of user participation and involvement in system development, the extent of business process and needs assessment during the analysis stage of the systems development process, and the level of data integration designed into the system (e.g., Govindarajan and Fisher, 1990; Zaheer and Venkatraman, 1994; Nicolaou, 2000). In a similar fashion, researchers in the fields of accounting and management decision making have promoted the shared assumption that a better designed information system would contribute to the efficiency with which organizational functions are carried out and the effectiveness of attaining desired outcomes (Galbraith, 1995; Zimmerman, 1995). Consequently, the factors that influence the process of system development would also have a significant effect on both organizational performance and user perceptions about the system after its implementation and continued use in an organization, that is, during its postimplementation stage.

The postimplementation stage in a system's life cycle encompasses a number of processes that are critical for a system's success. Following the implementation of the system, an organization would engage in a number of activities, such as postimplementation review (PIR), support, and maintenance (e.g., Gelinas and Sutton, 2002). The focus of this paper is on the process of PIR, which entails analyzing the project to determine what was successful and what needs to be improved with regard to the system or with regard to the implementation process itself (Burch, 1992; Cerullo, 1982; Gelinas and Sutton, 2002). Although past literature has provided a useful descriptive analysis of the PIR process (Benchmarking Partners, 1998; Holland and Light, 2001; James and Wolf, 2000; Peterson et al., 2001), the focus has mostly been on the development of stage models that describe a set of sequential activities useful for the planning of future actions and not on the examination and understanding of factors that contribute to process effectiveness. In a stage model of system development, the quality of a PIR is heavily dependent on the quality of the implementation process itself and on its effectiveness to influence appropriate modifications or enhancements that can improve the performance of the system or improve the project management and system development processes. With the recent expansion in the number of organizations using enterprise-wide systems, including both large and small organizations, and the Web-based capabilities they now offer, the successful implementation of these systems has become a critical issue. In addition, a very significant investment in resources is required for the implementation of enterprise resource planning (ERP) systems, while the realization of system benefits is reported to significantly lag expectations (Benchmarking Partners, 1998; META Group, 1999; Peterson et al., 2001). As a result, the issue of PIR and its potential effect on the realization of potential system outcomes provides a new area of research of significant interest to both researchers and practitioners and provides a solid motivation for the present study.

This paper examines issues that contribute to high-quality PIRs in ERP systems. The study explores the concept of PIR and attempts to develop a conceptual definition of high-

quality PIRs. As the PIR process cannot exist independently of the system implementation process, a number of implementation factors will be explored that should be the focus of review on a postimplementation basis. The study utilizes an exploratory, qualitative research approach in examining the concept of PIR and its potential importance in successful ERP system implementations. As the quote from Aristotle's *Nicomachean Ethics* implies, high-quality concepts require systematic inquiry that addresses a comprehensive set of dimensions.

A clear articulation of this concept will help enhance our understanding of the system development process in ERP systems. The study reported in this paper employed an exploratory qualitative method to accomplish this objective. Two organizations were examined in detail with regard to their PIR activities and useful insights were derived relating to the extent that specific review activities were important for a successful ERP implementation effort. This study, therefore, can provide contributions for past research in that the frameworks developed in past studies can be reexamined to include the concept of PIR quality as an important condition that moderates the attainment of system success/process outcomes. Furthermore, the quality of the PIR process could represent a key element in the examination of the relationship between system implementation and the realization of anticipated benefits from the use of ERP systems.

The remainder of this paper is organized as follows. The next section reviews literature that examines the implementation of ERP systems and the necessity for carrying out PIRs. The following section explains the qualitative research method adopted for this study and presents case study evidence that relates to the constructs of the study. A proposed conceptual definition of the quality of the PIR process is then developed which is consistent with both prior research and the case study evidence presented in the earlier section. The paper concludes with recommendations for future research.

2. Literature review

2.1. Literature on ERP systems implementation

ERP systems are organized around the basic economic rationale of the enterprise value chain. They are designed around a process view of the business, and they contain data useful in the value accumulation sequence. The major advantage of ERP systems over application software suites, which still service accounting conventions and needs, lies in their consequent integration of accounting transaction processing with workflow, design, and engineering management (McCarthy et al., 1996). It is widely reported in the literature that enterprise-wide applications promise seamless integration of all information flowing through a company: accounting and financial information, human resource information, supply chain information, and customer information (Davenport, 1998; Kumar and Van Hillegersberg, 2000). Several studies on ERP implementation (Murray and Coffin, 2001; Ross and Vitale, 2000; Scott and Vessey, 2000; Soh et al., 2000; Stephanou, 2000) have identified such issues as top management support, an effective implementation team, organizational-wide commitment to the system, and the effective resolution of misalign-

ments between organizational needs and the ERP package functionality, as critical factors for the success of an ERP implementation project.

2.1.1. Expected benefits from ERP systems implementation

ERPs are designed to help manage organizational resources in an integrated manner. The primary benefits that are expected to result from their implementation are closely related to the level of integration that is promoted across functions in an enterprise. The professional literature has been proactive in determining the types of benefits that companies might anticipate from their ERP systems and to what extent organizations had actually attained those benefits on a postimplementation basis. Expectations for improved business performance after adoption may result from both operational and strategic benefits (Irving, 1999; Jenson and Johnson, 1999). In the Benchmarking Partners (1998) study, respondent companies anticipated both tangible and intangible benefits. The most significant intangible benefits related to internal integration, improved information and processes, and improved customer service, while tangible benefits related to cost efficiencies in inventory, personnel, procurement and the time needed to close books, as well as improvements in productivity, cash/order management, and overall profitability. In assessing the extent to which they had actually attained those benefits, however, on a postimplementation basis, it was evident that they were not able to improve profitability or lower personnel, inventories, or system maintenance costs as much as they had hoped. On the other hand, respondents noted better-than-expected results in overall productivity and in order-management cycle time, as well as procurement, on-time delivery, and the ability to close financial cycles. Likewise, in the Conference Board study (Peterson et al., 2001), responding companies reported anticipating similar types of tangible and intangible benefits, although it was evident that the realization of those benefits required more time than expected.

2.1.2. Factors of failure in ERP systems implementation

An AMR research study (Carlino et al., 2000) has projected that the enterprise applications market will reach US$79 billion by 2004. Despite such huge investments in ERP systems, many implementations have been plagued with failure. In a survey of 63 large Fortune 500 companies, META Group (1999) reports that over a 5- to 6-year period, the average company incurred a negative return of US$1.5 million from the ERP system implementation. In addition, the average implementation time for a full-blown ERP system was 23 months, at a cost of US$10.6 million for the implementation and another US$2.1 million for maintenance over a 2-year period (META Group, 1999). In addition, several case studies exist of companies that were led into severe financial distress because of system integration problems after the implementation of ERP systems. For example, Unisource Worldwide wrote off US$168 million in costs related to an abandoned implementation of SAP software (Stein, 1998). The computer integration problems that FoxMeyer Health has faced after the implementation of SAP software have led the company to a bankruptcy filing, instead of realizing the expected benefits of cost reduction, improved inventory turnover, and increased availability of useful information (Hyde, 1996). Several other high-profile ERP projects, such as Dell Computer, Dow Chemical, Hershey Food Cooperation, Whirlpool, and Gore-text have also failed to

implement an ERP package as intended (Davenport, 1998). In some cases, companies lost not only the capital invested in ERP, but also a portion of their business. As a result, there is some skepticism associated with the ability of ERP projects to deliver anticipated benefits (Bingi et al., 1999; Gable, 1998; Mabert et al., 2001). An important reason for these failures is that the implemented ERP systems suffer from system integration problems; the lack of alignment between people, processes, and the new technology preclude an organization from realizing anticipated benefits or even to recover the cost of the implementation effort (e.g., Davenport, 1998).

Moreover, the initial justification that drives the development of an ERP system also is considered an important reason for success or failure (Peterson et al., 2001). System-led implementations have a higher incidence of failure compared to those that are business-led. Yet, many ERP initiatives are still systems-driven, with the great majority of nonquantifiable business cases being focused on system issues, such as replacing legacy systems and attaining systems integration (Peterson et al., 2001). Likewise, the META Group (1999) survey reports that system implementation is most often justified on the need to improve internal integration, to support growth, and to support new processes or a changed business model in a firm's supply chain. For systems-led implementation efforts, it is often hard to measure and evaluate attainment of anticipated benefits, easier to distract from the original system scope, and business benefits lag in terms of their realization due to adjustments needed in the system's postimplementation phase.

Furthermore, it is also widely recognized that lack of user training and failure to completely understand how enterprise applications change business processes are important factors of failure (Wilder and Davis, 1998). According to the Benchmarking Partners (1998) report, major "go-live" surprises that companies experienced related to the fact that it was difficult for people to grasp the degree of discipline that was required on a daily basis due to the degree of integration imposed by the ERP system. Users could not fully realize that their actions now had an immediate impact on downstream operations. Companies were also surprised by the knowledge gap between the training employed and what people needed to work effectively with the new ERP system. Training might have been provided too early, or there was not enough, or the wrong training was provided. The sheer volume of training overwhelmed some users, while others were further confused by the lack of training about the context of the new capability from a business standpoint.

Despite its risks, ERP implementation is pervasive in many different types of industries (Kumar and Van Hillegersberg, 2000; Mabert et al., 2000). The goals of ERP systems implementation extend beyond internal business process integration to external connectivity and support of a firm's value chain activities. ERP vendors are changing their business model as they move toward a component strategy, often Web-based, that separates ERP systems into modules that can be adopted individually, thus permitting small- and medium-sized businesses to adopt such systems and improve their operations (Sprott, 2000). McCarthy et al. (1996) also support this argument by suggesting that ERP systems must retain their enterprise objective but must adopt a much simpler and flexible implementation. There seems to be a consensus on the need for interoperable components that can be customized to model a particular enterprise as close as possible to its actual way of doing business.

Given the significance and risk of ERP projects, it is essential that research examines methods to improve ERP implementation. This research will focus on the issue of defining the construct of quality in the PIR process. A well-planned and well-executed PIR of the ERP system implementation should assist organizations to effect needed changes in organizational plans and processes, avoid implementation risks, and realize potential operational and strategic benefits.

Table 1 summarizes the discussion in this literature review section. The first column in the table presents the critical implementation factors as they have been presented in the academic and professional literature that was reviewed here; the second column in the table presents the corresponding PIR dimensions that an ERP adopting organization should be expected to evaluate to ensure a high-quality PIR process and successful implementation of an ERP system. The dimensions in the table should be useful in guiding the analysis of the qualitative data that were collected in the present study and are reported in a following section of this paper.

2.2. PIR of ERP systems

The professional literature on IS implementation indicates that in actual system implementations, practitioners strongly recommend the use of PIR to improve the design and effectiveness of an already developed system (Caldwell and Stein, 1998; Holland and Light, 2001; James and Wolf, 2000; Peterson et al., 2001). IS implementations share similar characteristics with the implementation of capital budgets, in that they both involve a continuous implementation process that is subject to a PIR. The recommendations from the IS professional literature, therefore, can be conceptually justified on research findings reported in the field of capital budgeting systems implementation, where postimplementation issues have been the subject of past research (e.g., Chenhall and Morris, 1993; Gordon and Smith, 1992; Morgan and Tang, 1993; Myers et al., 1991; Neale, 1991; Pike, 1988). This section reviews empirical findings from the capital

Table 1
Critical factors of ERP implementation and corresponding PIR dimensions

Critical factors of ERP implementation	Critical dimensions of PIR
• Top management support and commitment to project; fit to business strategy.	• Evaluation of fit with strategic vision. • Review of project planning effectiveness. • Evaluation of infrastructure development.
• Alignment of people, process, technology.	• Review of fit resolution strategies. • Evaluation of system integration attainment and reporting flexibility.
• Anticipated benefits from ERP implementation project. • Motivation behind ERP implementation (business- vs. system-led). • Scope of user training.	• Evaluation of level of attainment of expected system benefits. • Review of driving principles for project. • Review of project justification practices. • Review of user learning. • Evaluation of effective knowledge transfer (among project team members and other users).

budgeting literature and also discusses related studies describing characteristics of the IS PIR process.

2.2.1. PIR in capital budgeting research

The capital budgeting literature has defined a PIR or a postcompletion audit (PCA) as a feedback device that systematically monitors the progress of an investment project by comparing actual performance with budgets developed when a project was originally evaluated (Horngren and Foster, 1991). The primary focus of PCA was therefore to identify and possibly abandon any poorly performing assets, and also to provide feedback to improve any moderate to well-performing assets and enhance the quality of future investment decisions. It was apparent that PCA had a control focus; the extent of ''sophistication'' in the capital budgeting process implied the use of such sophisticated techniques in both the planning (predecision) stage of a project, and the control (postdecision) stage. In general, sophisticated postauditing was evaluated using the following criteria (Chenhall and Morris, 1993; Gordon and Smith, 1992; Myers et al., 1991): (a) use of quantitative models (e.g., discounted cash flows) to identify poorly performing assets; (b) use of regular periodic reviews versus one-time reviews; (c) extent of documentation of postaudit procedures (assumed to legitimize project abandonment decisions and routinize the entire control process); (d) extent to which postaudit procedures were applied as a percentage of capital projects (in terms of dollar values) postaudited by a firm; and (e) use of formal versus informal postaudit procedures.

Empirical findings from capital budgeting research indicate that the level of postauditing sophistication is an important issue. Firms that do a limited amount of postauditing and/or handle postaudits in a naive fashion do not exhibit significantly different outcomes from firms that do not perform postaudits at all. Second, it appears that the economic benefits of sophisticated postauditing exceed costs in some cases, but not in others (Gordon and Smith, 1992; Pike, 1988). For example, firms with a more complex operating environment appear to benefit the most from the use of sophisticated postauditing, while perceived environmental uncertainty was also identified as a key moderator in the effects of postauditing sophistication on learning (feedback value) and performance (Chenhall and Morris, 1993). In addition, firms with failing projects were also identified to benefit from sophisticated postauditing (Myers et al., 1991). As a result, this literature has identified firm-specific factors that might moderate the performance effects of postauditing sophistication but has also demonstrated that sophisticated postaudits were useful in making decisions to abandon, continue, or enhance projects or to suggest changes to improve future project selection.

2.2.2. PIR in IS literature

The importance of PIR for IS has also been presented in the early systems implementation literature (e.g., Burch, 1992; Cerullo, 1982; Mason, 1975). A number of elements are presented as part of the PIR process, which center around the issue of whether the scope and benefits of the implemented system are compatible with the intended system scope and anticipated benefits. A few descriptive studies in this area (Kumar, 1990; Ward et al., 1996) have also suggested that the PIR process should be an important part of evaluation (in the implementation of legacy systems), although the practices that were

empirically identified did not follow this prescription. The findings of those studies demonstrated that system review practices resembled a tactic of project disengagement by system designers and were not done to either assess system impact or provide feedback to modify inappropriate development and project management. It was still recommended, however, that PIR should include an evaluation of system impacts using a long-term view, be conducted by users, and formalized. The review should also be conducted after the system matured so that it would be possible to evaluate impacts on the organization, the system users, and their effectiveness.

Several industry reports on ERP systems have presented PIR as an important process in the life cycle of system development. A number of stage models were presented in the professional literature, including a three- (Holland and Light, 2001) and five-stage (Ross and Vitale, 2000) ERP system development and evolvement models, as well as a three-stage postimplementation maturity model (Benchmarking Partners, 1998).

In the Benchmarking Partners (1998) report, postimplementation activity in ERP systems is segmented into three major stages. In the first stage, a company may experience a 3- to 6-month productivity decline, which is overcome by redefining jobs, establishing new procedures, fine-tuning ERP software, and taking charge of the new streams of information created by the ERP system. The second stage, which lasts from 6 to 18 months, involves skills development, structural changes, process integration, and add-on technologies that expand ERP functionality. The PIR process could be conducted within these two stages. The PIR outcomes would then be used to resolve problems in these stages and move the organization forward to further attain additional system benefits. Consistent with this argument, professional reports argue that fundamental to the success of the PIR process are cultural and organizational shifts (Caldwell and Stein, 1998), which should follow a high-quality PIR. Such adjustments in the postimplementation stage are intended to align technology and business management objectives (Caldwell and Stein, 1998; Davenport, 1998); as such, they are not part of the PIR process but rather should result from a high-quality PIR process. The third stage in the Benchmarking Partners (1998) report, therefore, is presented to involve business transformation, where the synergies of people, processes, and technology can reach their peak. Many of the companies participating in the study had also realized that their ERP packages included only 50–75% of the technology they needed to get the full benefits of their systems. Post-ERP applications introduced at this stage of postimplementation maturity, such as sales-force automation, customer relationship management, data mining, and supply chain management systems, promise to increase efficiency in handling transactions, improve decision making, and further transform ways of doing business.

Furthermore, Grabski et al. (2000) identify four different organizational interventions to minimize the risk associated with unsuccessful ERP implementation. These interventions include business process reengineering, detailed requirements specification for system selection, system testing prior to implementation, and monitoring of the system after its implementation. Monitoring the system on a postimplementation basis is a critical process that is designed to ensure that the ERP system operates smoothly and is able to provide adequate support for the organization's operational processes. Wilder and Davis (1998) also suggest that an important role of postimplementation is to redefine and/or limit the

scope of the ERP project, in case of an initial failure, and promoting learning and system acceptance in the organization through user training and stakeholder commitment to the system.

Both the literature and industry surveys cited above, therefore, point to the importance of the PIR process. The critical factors of ERP implementation that were summarized in Table 1 demonstrate that the PIR process should consider a number of critical dimensions to avoid implementation risks and contribute to a successful implementation. The findings from the management accounting research further demonstrate that it is the quality of PIR that is significant if an organization is to progress through the various levels and achieve desired benefits. The descriptive IS studies also demonstrate that a high-quality PIR should be a planned process that involves system users and is conducted after the system has reached a relative stage of maturity to evaluate the impact on the organization and the users. The quality of PIR that is carried out by an organization should therefore be closely related to the actual level of achievement of expected outcomes from ERP system use. The following research proposition can be advanced at this point, which can serve as a guiding framework in the exploration of the PIR quality concept.

RP: The quality of post-implementation review that is carried out in an organization will have a significant influence on the realization of expected outcomes from the use of ERP systems.

The next section employs the case study method to enhance the substantive validity of the concepts presented in this study.

3. Research method

This study has the objective to explore the concept of PIR in ERP systems and identify the factors that lead to high-quality PIRs. Such "why" questions can be answered using the case study method (Yin, 1994). A qualitative approach was used to analyze a series of events exhibiting some theoretical principles. The purpose was to explore in detail the dynamics present in relevant organizations and conceptually interpret the significance of various factors that influence the quality of PIRs. In this regard, Eishenhardt's (1989) conceptualization of the case study methodology was followed in an attempt to understand the concepts involved in the field of PIR in ERP systems and define the substantive domain of these concepts and their relationships. The literature that was reviewed in prior sections offered the opportunity to formulate a general research proposition and identify factors of potential interest in evaluating the quality of PIRs in ERP systems. These factors were further explored by carrying out semistructured interviews in two different organizations, which had implemented ERP systems.

The selection of the two organizations was based on the need to collect detailed data about the ERP implementation process in each organization. The organizations were varied significantly in size, in type of industry, and also in their degree of "success" in their ERP system implementation effort. One organization was a large Fortune 500 manufacturing corporation operating globally (hereafter referred to as 'MANU'), while the other was a

medium-size utility operating in a European country (hereafter referred to as 'UTIL') preparing to enter the new unregulated environment of the European Union.

Personal interviews were carried out with the Corporate Directors of Information Technology in both companies. The interviews were conducted during the spring and summer of 2002. In both cases, an initial interview was carried out, the observations obtained were further considered, and a second interview with the same individual followed for further explanations. The semistructured interviews were guided by an interview protocol, which is shown in the following Exhibit 1.

Exhibit 1. Interview Protocol

1. What were the driving forces for the system change to an ERP architecture?
2. Was there a strategic plan in place to guide the deployment of the new ERP system? What were the specific principles that guided system development as part of the strategic plan?
3. Looking back at the implementation process, what were those factors that critically determined implementation success or failure?
4. On a postimplementation basis, what actions were taken to enhance system functionality, review the system's service potential, or evaluate user acceptance?
5. Could specific success factors be identified that were discovered during the postimplementation phase of the system life cycle? What tools were used for their measurement, if any?

Although the researcher did not collect archival data from the two organizations, the individuals interviewed often referred to internal documentation or sought the help of in-house experts in responding to the researcher's inquiries. The researcher also met with those in-house experts, who provided more detailed information on several of the issues presented in the interview protocol. All interviews were tape-recorded. Following each interview, the researcher listened to the tapes and transcribed the various comments made by each interviewee. The following sections present the observations from these interviews with regard to the driving forces and principles for ERP implementation in the two companies, as well as significant issues relating to the implementation process.

4. Case evidence

4.1. Case background: MANU

MANU had a long history of in-house development of legacy systems that addressed different needs for its separate business units. By the year 1995, there existed more than 200 legacy systems that were in serious need of upgrading. In addition, the company was burdened with a significant cost associated with the maintenance of these systems. There were data inconsistencies in those systems across business units and it was impossible for the corporation to provide for data integration using those same applications. These

inconsistencies also made much more difficult any system documentation and maintenance tasks.

Customer service presented significant problems to the company because it was fragmented and costly. Existing legacy systems were focused on specific departments and lacked the ability to present a single "face" to the customer. A customer with queries that related to different products had to contact different people at different operating divisions, often receiving conflicting information. As a result, internal cooperation and effective management of operations were hindered by inconsistencies in the developed systems. In addition, external firm growth through acquisitions of other businesses was almost impossible to accomplish due to the great obstacles involved in the integration of the company's systems and processes with those of the acquired companies. The degree of operating complexity in MANU was therefore at a very high level and any system development effort had to address the complexity of issues that characterized its operations.

Given the above problems with the corporation's existing legacy systems, the decision was made to deploy an enterprise-wide system that would span all processes and business units of the company. The company had begun implementation of the SAP system across its business units in 1995. In addition, it required its divisions to provide quantifiable business cases before initiating the system implementation effort. Most quantifiable benefits related to improvements in customer response time, improved turnover by maintaining existing customers or by gaining customers from the competition, and by attaining efficiencies of scope through acquisitions of other businesses in its vertical supply chain. The ERP system was considered to be a significant facilitator for the straightforward integration of new acquisitions into the company's information infrastructure.

MANU had implemented modules relating to sales and distribution processes, materials management processes, production planning processes, and financial and management control processes. The new system required the setup of some 30,000 programs within SAP that accessed data in 7000 different database tables. System configuration was a very arduous task that involved multidisciplinary teams of internal people and external consultants. The company's system analysts had configured programs to automatically execute the appropriate business rules when relevant data were entered into the system. In addition, the system analysts had to develop several custom reports in addition to the ones already provided by the system to satisfy specific user needs. By the end of the year 1999, the company had implemented the SAP system in all of its business units on a global basis.

4.2. Case background: UTIL

UTIL had a primary objective of improving operational efficiencies, while ERP adoption was initiated in 1997 to replace a number of legacy, functional systems. The SAP R/3 system was selected at the time, based on a detailed requirements analysis that apparently matched a strategic plan that was put in place at the same time.

The company operated in a regulated environment in the energy business (electric utility). Although its regulated environment presented some advantages in terms of protecting UTIL from competitive forces at that time, it also required customized reporting that could not be easily accomplished without significant customization to the ERP system. From the start of the project, therefore, there existed significant idiosyncrasies that

hindered process integration and limited the process reengineering effort. The level of operating complexity in UTIL might not have been as high as that in MANU, although its specialized reporting needs rendered system selection and development a difficult task.

UTIL's top management believed that the integrated nature of an ERP system made necessary the transfer of data control solely to users, without having the information technology (IT) department involved in the process. External system consultants were hired to assist users in the implementation process; however, the project teams lacked both the in-house technical expertise to match business and system requirements and also lacked the overall understanding of business processes and how should those be evaluated or reengineered to successfully implement the system. In addition, the system was greatly customized to fix reporting inadequacies and prepare specialized reports required by governmental mandatory reporting requirements.

After 2 years of unsuccessful efforts, the implementation was turned over to the IT department with a deadline to be operational in 14 months, including the completion of all necessary customizations. To meet the deadlines, numerous short cuts were followed and work-arounds were adopted. Configuration management controls were by-passed and system testing became superficial. The implementation effort was completed and the system was eventually implemented with significant delays and cost overruns. End users did not fully accept the system and the training provided was just designed to train users in specific system functionalities, without learning the system's capability as a whole. Top management did not consider the ERP system implementation as an ongoing project but just as another IS project.

Eventually, SAP ceased support of the version implemented and it became apparent that a system upgrade was necessary. At this time, top management, users, process experts, and the IT department are all involved in the effort which shares more characteristics of an initial implementation rather than just a simple system upgrade. UTIL's top management realized that the system implementation effort has to be viewed as an ongoing process, where the basic infrastructure that is built through process redesign and integration can offer strategic advantages in the future. System implementation is not viewed any longer as just a single project but as an overall long-term effort for the development of a new business model that would ensure sustainability in the company's existing competitive advantage. UTIL is now operating in a deregulated environment, primarily due to the

identified to correspond to the critical factors of ERP implementation were reconsidered and used to classify the various PIR practices followed at each of the two companies. Table 2 presents in summary format the observations from the two companies along the five critical PIR dimensions.

Each of the two companies is identified to have followed a very divergent PIR path; it is evident, however, that the range and types of PIR practices that each followed depended on how well they managed the various issues during the initial implementation of the project. To the extent that critical factors of implementation were initially dealt with in a satisfactory manner, PIR could have been performed using a planned approach rather than a reactive approach to problem resolution, and take into account system user and organizational needs. The quality of PIR could therefore be affected by the extent to which an organization follows a planned approach in dealing with each of the five critical dimensions. The following section, therefore, presents a comparative analysis of the PIR practices at the two companies, organized by each one of the five major dimensions.

Table 2
PIR practices at MANU and UTIL

PIR Dimension	MANU	UTIL
I. Review of overall project scope and planning	• Evaluated system fit with strategic vision for organizational transformation. • Project planning evaluated and changes instituted in subsequent implementation teams. • Information infrastructure considered critical for survival, competitive advantage.	• Evaluated fit with strategic vision; support focus. • No formal evaluation of project planning but instituted changes after initial failure. • Information infrastructure had support role for organization; not a driver for competitive advantage.
II. Review of driving principles for project development	• Initial reactive response to problems due to implementation process inadequacies introduced by system. • Formally reviewed process integration and formed process review teams within process-oriented competence centers. • Evaluated global reach and support. • Reevaluation of initial system justification.	• No formal review of process integration; primarily reactive review due to problems identified by key users. • No review of business justification; system change after failure and due to termination of support by vendor.
III. Effectiveness of misfit resolution strategies	• Evaluated process simplicity and implemented 80:20 rule.	• Evaluated process and reporting inadequacies and developed "work-arounds" to bypass system deficiencies.
IV. Evaluation of attained benefits	• Evaluated benefits—primarily those related to customer satisfaction using customer surveys.	• No formal evaluation of benefits; lack of benefits was evident due to user complaints.
V. Evaluation of learning	• Reviewed user learning and instituted corrective mechanisms. • Evaluated knowledge transfer among implementation teams (multisite implementations).	• User training not evaluated; limited initial training and lack of interest in system.

4.4. Review of overall project scope and planning

4.4.1. Evaluation of system fit with organizational strategic vision

An important consideration in the system design and implementation processes, in both companies, related to the degree of fit of the system with each organization's strategic vision. In MANU, the ERP system implementation was part of a larger reorganization effort and the system was viewed as a medium that would ensure competitive parity, facilitate corporate expansion, and subsequently enable the attainment of competitive advantage in the global markets that the company was competing. The system therefore was viewed as critical for the company's long-term success. On a postimplementation basis, the company continuously evaluated system fit and further expanded the system. In UTIL, the project to implement an ERP system was much more limited in scope. Although the organization had carried out a strategic planning analysis before initiating system implementation, the service orientation of the organization, combined with idiosyncratic reporting requirements, contributed to a very low level of fit between the choice of the SAP system and the organization's objectives. At the time the strategic planning analysis was conducted, the organization did not expect any significant changes in its markets or competitive environment, although such challenges were later evident. System scope was therefore initially limited to a support role and was not viewed as critical for the attainment of any objectives beyond those relating to a desire to improve operational efficiency. In light of the new challenges facing the organization, system fit was reevaluated on a postimplementation basis and the decision was made to entirely redesign the system, while introducing major process changes at the same time.

4.4.2. Project planning

Both companies had followed an implementation approach that is often referred to as the "big bang" approach, in that the old system was discarded and all modules of the new system were introduced into each business unit over a weekend. Although the big bang approach presents a number of advantages, as it does not require simultaneous attention to both legacy and ERP software, it requires peak resource utilization in a short period of time with lower resources available to address problems for particular modules, thus increasing the risk of total system failure (O'Leary, 2000, pp. 152–156).

The strategic importance of each project also had a significant effect on the level of support provided by senior management to empower the corresponding system implementation teams to streamline business processes, to educate users to insure system acceptance, and to respond to user resistance to change. MANU's implementation team had the express support of senior management from the very beginning of the project. In the design and planning of its system, MANU had used implementation teams of IS experts, process experts, business experts (users), and consultants. All these people were solely involved with the enterprise system design project on a full-time basis. To achieve this task, the company has outsourced its whole legacy systems environment including help desk, PC support, and network management. For the first business unit of the company going live with the enterprise system, the team has worked together for about 3 years to complete the planning, design, and implementation of the system. The variety of people involved in the team brought in a level of expertise, which ensured that business

processes were adequately considered in the design of the parameters in the new system, and possible compromises in business functionality were adequately evaluated. The level of review on a postimplementation basis related to an evaluation of the effectiveness of project teams and the transfer of such knowledge to subsequent teams involved with system implementation at other company sites.

UTIL's senior management provided its full support to the system implementation team after the initial failure, with the consequence of not allowing the organization to adequately develop its information infrastructure except after a second major system implementation effort was to be completed. As a result, UTIL did not perform an adequate effort on project planning. In their initial structure, implementation teams included user representatives and consultants only. IS specialists were only involved in the implementation process at a later time, after the initial failed attempts to successfully install the system. This PIR of team effectiveness obviously indicated the inadequacies in team composition, which had the consequence of not adequately planning the project and failing to meet even the basic system support objectives.

4.4.3. Evaluation of infrastructure development

In MANU, the implementation of the ERP system was considered critical for the company's competitive position. As a result, the company evaluated the capabilities offered by this information infrastructure and further proceeded to the implementation of post-ERP applications. Among the post-ERP technologies that the company has implemented is a data warehouse that analyzes the wealth of new data generated by its SAP system. The warehouse provides valuable information on customer profitability, product-line profitability, sales performance, and supply chain activities. The company is also investigating applications for warehouse automation and tighter ERP integration with shop-floor process control, while its current strategic theme is on "supply chain transformation." In UTIL, the evaluation of its information infrastructure on a post-implementation basis has identified significant deficiencies in helping the organization meet its current objectives of providing competitive services and expanding in new markets where competitive pricing and innovation are the norm. As a result, UTIL has reevaluated its resource capabilities, reformed a more effective and more empowered implementation team, and embarked on a new system implementation effort.

4.5. Review of driving principles for the deployment of the enterprise system

MANU has set three major driving principles that had to be met in the design and implementation of the new enterprise system. These related to the need for (a) common processes, (b) simplicity in implementation and use, and (c) global support, given the widespread presence of the company's business units across the globe. UTIL also initiated its ERP implementation project with the goal to attain internal integration in its business processes and simplify the application of complex procedures. The issues of process integration and global support will be discussed in this section, while simplicity of system use is discussed in the following section, among the discussion of misfit resolution strategies.

In MANU, process commonality was operationalized in such a way so that similar functions across business units should be executed in the same way. For example, common

processes for order processing with regard to the various products in different divisions should be done in the same way. Although this imposed commonality in functions across business units had at first created problems because of changes in the traditional manner of operation and in power relationships, it proved to be more effective in that it had helped to improve customer satisfaction across business units. Since the initial implementation of the system, MANU has gone through a comprehensive program of process review and evaluation. This programmed or planned PIR activity resulted in several cultural and organizational changes, including the formation of "process review boards" responsible for the evaluation of proposals for the development of new or modified system applications. Those process-oriented system evaluation teams in turn operated within the context of "competence centers", which resulted from a total reorganization of the IT function and the adoption of a process vision for technological support, training, and identification of new system challenges and opportunities. Finally, the global support principle of the company stipulated that system improvements could be done across businesses and system implementation could be achieved on a global platform. The global impact of process commonality was also evaluated as part of the company's programmed review of process commonality.

In UTIL, internal integration among its various business processes was a primary objective that was considered to eventually lead to operational efficiencies. The lack of an effective implementation team, however, coupled with the limited strategic scope attributed to the system implementation, led to failure in even meeting this basic objective. For example, system modules were implemented with various degrees of success. The customer billing module, for instance, was not an integral part of the organization's enterprise system. Although billing represented one of the most important modules, it also required extensive customization that was impossible to achieve given the state of the organization's resources and commitment to the system. As a result, it remained as an external module, operating through an offline monthly interface. On a postimplementation basis, process integration was not formally evaluated but management's attention to system inadequacies was brought about due to numerous complaints received by system users.

Although both companies appeared to be motivated by system-led factors in their ERP implementation efforts, MANU did require its business units to justify system implementation based on specific bottom-line improvements. Within this context, the company also reevaluated initial system justifications provided by business units and the process-oriented competence centers took action to remedy any problems in areas that needed attention. In UTIL, there was no formal review of the initial system justification on a postimplementation basis. The changes in the system scope and in the redesign of business processes became necessary due to the termination of system support by the vendor and due to the postimplementation "realization" that the system as implemented could not support the organization's strategic objectives.

4.6. Effectiveness of misfit resolution strategies

One of the driving principles for ERP system implementation at MANU related to the simplicity in the implementation and use of the system. Implicitly, UTIL also desired such

simplicity, due to its goal of improving operational efficiency, although such goal was not explicitly stated.

Although simplicity might be a desired goal, it may not always be achieved without any costs. More simple processes are necessarily more generic in nature and they may not provide a good match with specific business requirements. MANU tried to balance this concern through the application of a generic 80:20 rule to evaluate the trade-off between increased levels of simplicity in business processes versus the extent of functionality lost. This rule specified that if simplified business processes could be implemented that met about 80% of business requirements, then they would be adopted without any further modification to the system. More simplified processes were considered to increase system usefulness across business units and geographical areas in addition to the fact that they were easier (less costly) to maintain and upgrade. However, where a significant discrepancy existed between the desired and actual level of business functionality (more than 20% according to the 80:20 rule), the company opted to either customize the package or implement "bolt-ons" (separate software modules) to satisfy specialized user needs. For example, the sales order module proved to be a rather complex function in a manufacturing environment, in direct opposition to retail businesses on which the generic design of the enterprise system was based. As a result, a bolt-on was implemented to perform that specific function. On a postimplementation basis, the company instituted the process review boards which handled user requests to either further customize the system or to implement additional functionality through bolt-on applications. As a result, PIR in this case was user-driven and was initiated in response to problems.

UTIL almost abandoned its ERP system due to significant misfits with its business processes and practices. In the professional literature, the most frequently cited reason for abandonment of ERP projects is the discovery that the system cannot support an organization's business processes (Koch et al., 1999). ERP systems have been designed around the idealistic view that there is a "universal" set of best practices. ERPs employ the traditional hierarchical, functional view of organizations (Kumar and Van Hillegersberg, 2000) so a mismatch between company-specific business practices and the ERP model is very likely to exist. As in MANU's case, PIR was problem- and user-driven. However, UTIL's response to such problems was to develop several work-arounds to minimize the gap between current practices and the system requirements. Numerous work-arounds were instituted to correct reporting inadequacies of the ERP system. A significant number of such reporting inadequacies, furthermore, were due to process fragmentation because critical applications, as was customer billing, were not part of the enterprise system's application suite. As a result, UTIL did not effectively use PIR to evaluate how to best redesign existing processes to improve efficiency of operations (a stated system goal). In consequence, UTIL could not successfully implement any post-ERP applications without first going through the process redesign effort in conjunction with the implementation of the new version of SAP.

4.7. Evaluation of attained benefits

To ensure that MANU would realize the anticipated benefits from the implementation of the enterprise system, its various business units were forced to document and justify

their own imperatives for such a massive system implementation effort. It was evident that the success of the system implementation effort in terms of attaining anticipated benefits depended on two critical factors: (a) the design of the system around the enterprise supply chain and (b) an early focus of the system design effort on quantifiable business outcomes. This focus has forced MANU's business units to make decisions that eliminated nonvalue adding processes or to simplify complex processes into a more simple structure that was common across the whole company. Designing the system around the enterprise supply chain provided the opportunity for increased efficiency in operations that had a pervasive effect throughout the whole enterprise. Such bottomline justifications, in many cases, related to improvements in customer service. An important PIR activity that MANU carried out was to formally assess customer satisfaction using specially designed customer surveys. The results of those surveys were subsequently used to further institute necessary changes in business processes; the company is currently embarking on a ''supply chain transformation'' initiative, building on its enterprise infrastructure and on supply chain directed applications (including both Web-based and Web-enabled applications).

Although UTIL had a primary business efficiency objective in adopting its ERP system, the implementation problems that were encountered and its process misfits with system requirements did not allow the company to realize these desired benefits. On a post-implementation basis, there was no formal activity in place to evaluate attainment of benefits. The lack of attainment of any such benefits was evident, however, primarily due to significant user complaints relating to process inefficiencies introduced by the new system.

4.8. Evaluation of learning

4.8.1. User training

It was the experience of both MANU and UTIL that, after the installation of the SAP system, users were overwhelmed and not well prepared for the process changes brought about by the enterprise system. In MANU, for instance, users were not fully aware of the pervasive effects of simple actions for the whole enterprise, such as entering a sales order. In the first few months after initial implementation, customer service was adversely affected in that customers often did not receive the products they had ordered and experienced delays in delivery. In addition, some very costly mistakes were made in other significant process areas, such as production scheduling and logistics. Part of the problem was due to the fact that employee training was initially constrained only to the functionality within SAP that users needed to do their jobs, without being provided with a clear and overall view of how the software operates. Because of the integrated nature of SAP, erroneous data in the one end of the process, e.g., in entering a sales order, affected the entire production and financial processes. MANU responded to these initial problems by radically changing its training methods, instituting a certification process, where employees would have to pass a certifying test before given access to the system. In UTIL, similar problems were encountered, where users were also not provided adequate training to ''learn the system'', but were just trained on performing specific functions within SAP that were necessary for their day-to-day responsibilities. On a postimplementation basis, and after some costly and time-consuming mistakes were discovered,

additional training was provided to users. In conclusion, the steep learning curve associated with the use of a complex enterprise system has led to errors and delays, significantly obstructing both companies' ability to realize anticipated benefits from the use of their ERP systems.

4.8.2. Knowledge transfer

Another critical consideration for user acceptance and for overall system success, after the implementation of the system, relates to the need for knowledge transfer. Knowledge transfer in a system's life cycle is also presented in the professional literature as a critical factor in managing the dependencies between people, business processes and events, and knowledge domains (Clark, 2000). Specifically, MANU has discovered on a postimplementation basis that it must ensure the continuity in the skills and knowledge acquired during the implementation process in order for the system to be used effectively and provide the anticipated benefits. On a postimplementation basis, it became evident to the company that this continuity in people skills and expertise could be greatly assisted by the existence of adequate process documentation and documentation of the functional knowledge that was acquired about the system during the implementation process. The absence of such continuity in UTIL, due to the lack of system and process documentation during the implementation of the system, contributed to dissatisfaction with the system, nonacceptance by users, and in project failure.

4.9. Overall cultural and organizational effects

In both UTIL and MANU, the postimplementation phase of their ERP systems necessarily led to changes in organizational power relations. In UTIL, the IT department gained more power over user departments, because the second implementation effort is under the direct supervision of the IT manager who has direct reporting responsibility to the CEO. The IT department has recruited individuals with both technical expertise as well as process expertise in the particular industry in anticipation of the new system implementation effort. In MANU, the cultural and organizational impact of the enterprise system has been dramatic. It necessitated structural changes in the IT organization, along with other postimplementation activities that ultimately led to front and back office integration. To fully utilize the expertise that the company has acquired through the repeated SAP implementations, the company's IT organization has moved away from being mainly a back office group to one involved in a broader range of core business activities. The company has changed its structure and created a number of competence centers so that its customer service, logistics, materials management, supply chain planning, and IT groups can best work under a common umbrella to effectively address post-ERP implementation challenges. In the literature, competence centers are presented as important not only for ERP software maintenance (for example, updating process tables as the business changes), but also as an invaluable resource for user education, support, and to promote ongoing improvements in business processes (Eriksen et al., 1999).

All of the above factors had greatly influenced the implementation of the ERP systems at the two companies and had shaped the users' predisposition toward the system after its initial implementation. As a result, based on the case findings, an overall conceptual model

of ERP postimplementation effectiveness may be presented that could be useful in future empirical investigations.

No attempt is made in this paper to validate this model. However, its derivation is based on the conclusions that can be drawn from the cases reported here and its main objective is to demonstrate the role of the "PIR quality" construct as an important condition that moderates the attainment of ERP implementation outcomes. As a result, the model constructs possess some apparent face validity, which nevertheless needs to be further examined in future empirical investigations. The following section presents an attempt to reach generalized conclusions with regard to the development of conceptual boundaries of the concept of PIR quality that might be significant in determining the success of an ERP system implementation effort.

5. Conceptual definition of the concept of PIR quality

The literature reviewed in an earlier section of this paper has shown that it is the quality of PIR that has an important effect on business performance and not the mere presence of PIR activities in an organization. In the two organizations described in the case study presented in this paper, for example, PIR was proactively executed in MANU, while in UTIL, it was just reactive in nature to address integration and other system implementation problems. A proactive PIR process, for example, would involve the planned examination of process matrices for more effective utilization of the enterprise system, resulting in more simple processes and global interfaces. In general, as demonstrated in Fig. 1, a high-quality PIR process should enable an organization to maximize the effectiveness of interventions during the implementation of the system and attain postimplementation effectiveness.

As it was discussed earlier in this paper, the most important culprits in a problematic ERP implementation are lack of user training and failure to completely understand how enterprise applications change business processes (Wilder and Davis, 1998). It is also emphasized by system professionals that for an organization to turn around after initial failure, it must engage in PIR that will assist in better defining the scope of the project and improving user training and acceptance of the system. This situation was demonstrated very eloquently in the case of UTIL, which had to redefine the project scope in turning around from initial failure. Organizations may expect to gain strategic advantages from the implementation of ERP systems. Such strategic advantages could be associated with (a) increased data accuracy that facilitates interactions with customers and suppliers and (b) improvements in the availability and quality of information due to improvements in business processes (Mabert et al., 2001). As a result, broad user training and acceptance of the system, in its postimplementation phase, are critical components in an organization's ability to realize such strategic benefits. In MANU, these factors were significant facilitators of system success.

A well-planned and well-executed PIR of the ERP system implementation, therefore, should assist organizations to effect needed changes in organizational plans and processes and realize potential operational and strategic benefits. The concept of "quality of PIR" that is carried out in an organization could therefore be defined by the extent to which an

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organization adopts the set of PIR dimensions identified in Table 2. The level of quality in the PIR process could therefore be evaluated by considering the extent to which an organization carries out a PIR program or plan that includes the set of activities implied within each of the five dimensions. Although each of the five dimensions implies the adoption of different practices, it is the cumulative outcome of these practices that determines the degree of quality in an organization's PIR process. As a result, the effect of each of the practices is complementary to one another and adoption of a specific practice does not render redundant any of the other practices. In the conceptual definition of PIR quality, therefore, it is the cumulative influence of these practices that should most strongly influence outcomes. It remains an important empirical question, therefore, to further operationally define the concept of PIR quality, examine the relative importance and contribution of individual practices on PIR quality (that is, examine construct validity), and test their influence on outcomes of postimplementation effectiveness (i.e., examine predictive validity).

6. Conclusions and recommendations for future research

This study has examined the empirical and professional literatures in ERP implementation and has also reported on a case study to further explain and substantiate the implementation process phenomena that were advocated in the literature. A general research proposition was advanced, which advocates that a relationship exists between the degree of quality in PIR carried out by an organization and the extent to which the organization attains desirable system outcomes. This research proposition should be empirically examined in future research to test the validity of the proposed concepts and determine the strength of their association.

The insights from the study have been used to conceptually define the construct of PIR quality and develop an overall conceptual model, which proposes potentially important conditions that influence the extent to which an organization could attain desired outcomes from an ERP system implementation. Conceptually, PIR could be defined by determining the extent to which an organization carries out a planned set of review/evaluation activities on a postimplementation basis, which relates to the following five dimensions: (a) review of overall project scope and planning; (b) review of driving principles for project development; (c) evaluation of misfit resolution strategies; (d) evaluation of attained benefits; and (e) evaluation of user and organizational learning. Each of these five PIR dimensions could be further examined in future studies, where operational measurement items can be developed and data on such specific items can be collected from firms that had adopted and deployed ERP systems in their organizational environments. These empirical measurements can then be tested to determine the validity of construct measurement in terms of construct representativeness, internal reliability of measurement, and discriminating ability in distinguishing the quality of PIR construct from its antecedent conditions and potential outcomes.

System benefits identified in the prior literature (e.g., Benchmarking Partners, 1998; META Group, 1999; O'Leary, 2000; Peterson et al., 2001) could be used as performance indicators for desirable ERP systems outcomes. Past research in systems implementation

has had difficulty in identifying positive returns on the investment of ERP systems (e.g., META Group, 1999; Poston and Grabski, 2001); furthermore, there is an entire literature on the so-called IT productivity paradox, where studies found little or no evidence of a relation between IT investment and firm performance (e.g., Barua et al., 1995; Brynjolfsson, 1993; Weill, 1992) or productivity (Loveman, 1988; Roach, 1987). In ERP systems, the difficulties associated with accurately predicting benefits could arise from implementation deficiencies and shifting business requirements, both of which could only be exacerbated by the pressure to go live (Peterson et al., 2001). A postimplementation effort that is solely directed to identify shortcomings and address deficiencies cannot contribute to the establishment of those conditions that enable organizations to generate better returns for their investments. The level of quality in PIR, therefore, as it was articulated in this research, could enhance our understanding of the ERP implementation process and propose conditions under which an organization could realize anticipated benefits and attain other desired system and organizational outcomes. Past research that advocates the universality of a productivity paradox in IT investments in general or ERP systems in particular should therefore be reevaluated in light of the PIR quality construct.

Future research could therefore empirically measure the extent to which organizations carrying out PIRs at varying levels of quality realize expected benefits with a varying degree of success. Future research could also examine the great number of different benefit types and develop clusters of benefits that could be more directly associated with an organization's long-term success. The actual process of PIR could also be further examined in future research to determine the timing of the PIR process, the nature of communication that is carried out throughout the process and how that impacts the attainment of each of the five dimensions identified here, the level of involvement of users, internal auditors or management in the process, and the level and extent of documentation that is required in the process. Although the present study presents "first" evidence on the nature of those factors that critically determine the level of quality in the process, it does not delimit the actual process of PIR and its comprising elements. As a result, this remains an important issue for future research.

In conclusion, this study has attempted to explore the quality of PIR construct, define the conceptual boundary of this construct, and suggest a general conceptual model that could be useful for both the practice and research on ERP implementation effectiveness. The lack of prior empirical findings in this area lends additional importance to such a research effort that explores potentially significant constructs and defines conceptual boundaries that could contribute to future empirical investigations.

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