A balanced scorecard based framework for assessing the strategic impacts of ERP systems

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Abstract

Although there is no analytical framework for assessing the organizational benefits of ERP systems, several researchers have indicated that the balanced scorecard (BSC) approach may be an appropriate technique for evaluating the performance of ERP systems. This paper fills this gap in the literature by providing a balanced-scorecard based framework for valuing the strategic contributions of an ERP system. Using a successful SAP implementation by a major international aircraft engine manufacturing and service organization as a case study, this paper illustrates that an ERP system does indeed impacts the business objectives of the firm and derives a new innovative ERP framework for valuing the strategic impacts of ERP systems. The ERP valuation framework, called here an ERP scorecard, integrates the four Kaplan and Norton’s balanced scorecard dimensions with Zuboff’s automate, informate and transformate goals of information systems to provide a practical approach for measuring the contributions and impacts of ERP systems on the strategic goals of the company.

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1. Introduction

ERP stands for Enterprise Resource Planning, and the term is used for any software system designed to support and automate the business processes of medium and large businesses. The well-known ERP systems are SAP R/3, Oracle Applications, PeopleSoft and Baan. The key characteristics of ERP systems are summarized below.

1. ERP systems are off-the-shelf pre-written software with sufficient flexibility to integrate most of the business processes of an enterprise.
2. ERP systems are at least an order larger than any traditional business application software. They are large in terms of function point measure. They are large in terms of business functionality. They are large in terms of the data items in the database. They are large in terms of the operational and management reports that can be generated.
3. ERP systems are very complex. Besides the usual correlation between size and complexity, there is...
an inherent data structures complexity in ERP systems because ERP modules do not share data by passing it from one module to another module but makes it available to different modules via common data structures.

4. ERP systems are built on generic business rules and procedures. Thus, each implementation requires tailoring and customizing the modules based on the business practices of the organization. This often entails reengineering many of the current business processes.

5. The organizational reach of ERP systems is wide, and therefore an ERP implementation requires dealing with a very large portion of the business operations of the organization.

6. ERP systems are costly to buy and more expensive to implement in an organization.

Since installing an ERP system is an expensive and risky venture, the technical and managerial challenges of implementing ERP systems are widely researched and analyzed in Refs. [1–5]. However, the problem of assessing the benefits of ERP systems is less well studied and understood despite the observation that the difficulties experienced in measuring the business value of ERP systems are not atypical of most IT projects. While there is some research that focuses on factors influencing ERP implementation success [6,4], the question of how to measure the benefits of ERP in use has been raised but not fully analyzed. Specifically, there is a lack of an analytic framework, suggested in Ref. [7], that can serve as a guide for identifying measures for assessing the benefits and success of ERP systems. The idea of developing an ERP balanced scorecard has been suggested by several authors but only Rosemann and Weise [8] have attempted to apply the balanced scorecard approach to the specific task of managing ERP systems.

This paper addresses two key questions: (1) does an ERP system impacts the strategic goals of a firm? and (2) can an analytical framework be built to systematically analyze the benefits and strategic contributions of an ERP system? Based on an analysis of a successful implementation of SAP in a global engine manufacturing and service organization this paper illustrates the applicability of the balanced scorecard (BSC) to ERP systems and derives a new valuation framework for discovering and defining ERP success measures that impact the business objectives and strategies of the organization. This new valuation framework, called the ERP scorecard, roots the four balanced scorecard dimensions into Zuboff’s [9] notions of automate, informate and transformate. The rest of paper is organized as follows. The next section presents a review of the appropriate research literature. This is followed with a description of the case organization and their SAP implementation process. Using the SAP implementation as a case study, we next show that an ERP system impacts the strategic goals of a firm and the four balanced scorecard dimensions are applicable to assess the benefits and measure the value-added contributions of ERP systems. After this, the derivation of a new ERP valuation framework, called an ERP scorecard, is described. The paper closes with a comprehensive summary of the contributions of this new ERP scorecard.

2. Review of the relevant ERP literature

Booth et al. [7] noted that no analytic framework exists to examine the potential benefits after the ERP system is successfully implemented and put in use. Markus and Tanis [4] and Markus et al. [20] identify various reasons, listed in Table 1, that motivate organizations to implement ERP systems. They also suggest that there should be a connection between the reasons for adoption to the benefits. For example, we can extract both financial and non-financial benefits of ERP systems from the reasons listed in Table 1. Financial benefits are reduction of computer operating costs, reduction of business operating and administrative expenses and reduction in inventory costs and stock outs, and non-financial measures are reduction in data errors, improved efficiency of business processes, and improved decision support. However, these benefits do not tell whether an ERP system impacts the strategic goals of a firm.

Shang and Seddon [10] compiled an ERP benefits list from ERP vendor success stories published on the Web. Follow-up interviews and analysis led Shang and Seddon to classify the different types of ERP benefits as: (1) IT infrastructure benefits, operational benefits, managerial benefits, strategic benefits and organizational benefits. The IT category consists of the typical IT department benefits arising from reduction in cost
of maintaining legacy systems. The operational benefits are those that arise from automating cross-functional processes. The managerial category includes benefits that arise from the use of data to better plan and manage production, manpower, inventory and physical resources and from the monitoring and control of financial performance of products, customers, business lines and geographic area. The strategic benefit category focuses on the benefits that arise from the systems ability to support business growth. The organizational benefits category captures the benefits derived from facilitating business learning, empowerment of staff and higher employee morale and satisfaction.

Shang and Seddon benefits categories can serve as a useful framework for evaluating the benefits of ERP systems. However, this framework does not link the benefits to the reasons for ERP implementation as recommended by Markus and Tanis [4]. Furthermore, Shang and Seddon categories do not consider the time frame for the benefits, as noted by Davenport [11] that there are different types of benefits from ERP system and some are likely to arise earlier than others.

Markus and Tanis [4] indicated that the balanced scorecard [12] might be the most appropriate technique for evaluating the benefits of ERP systems. The key insight of the balanced scorecard approach is that when non-financial measures about customer satisfaction, internal processes and ability to innovate and learn are combined with the financial measures they assure future financial results.

The application of the BSC has been examined in the context of IT and information systems. van Grembergen and van Bruggen [13] show that the BSC model can be applied to the IT function. They operationalize the four balanced scorecard dimensions of customer, finance, internal business processes and learning and growth as user-orientation, corporate contribution, operational excellence and future orientation, respectively. In Ref. [14], they illustrate the application of their IT balanced scorecard model for a Canadian Financial group.

The application of the BSC to ERP systems is discussed in Refs. [8,15]. Since BSC was conceptualized as an approach for strategic management of a firm, Rosemann and Wiese frame the application of BSC to ERP systems as strategic management of an ERP system. They partition the ERP strategic management processes into management of ERP implementation and management of operational use of ERP software, and they propose a separate balanced scorecard for each part. Since their work is conceptual, Rosemann and Wiese provide key question that drive the identification of measures in each of the four BSC dimensions for ERP implementation and ERP operational use, as shown in Table 2.

In our judgment, Rosemann and Wiese’s framing of BSC application to ERP arena is faulty because their ERP balanced scorecard approach does not connect with the business goals and strategy of the organization. We found that adapting and configuring van Grembergen’s BSC-IT framework to ERP systems

<table>
<thead>
<tr>
<th>Technical reasons</th>
<th>Business reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solve Y2K problem</td>
<td>Accommodate business growth</td>
</tr>
<tr>
<td>Replace hard-to maintain interfaces</td>
<td>Acquire multi language capability</td>
</tr>
<tr>
<td>Reduce software maintenance burden through outsourcing</td>
<td>Acquire multicurrency IT support</td>
</tr>
<tr>
<td>Eliminate redundant data entry</td>
<td>Improve inefficient business processes</td>
</tr>
<tr>
<td>Reduce data errors</td>
<td>Reduce business operating and administrative expenses</td>
</tr>
<tr>
<td>Decrease computer operating costs</td>
<td>Reduce inventory carrying costs and stock outs</td>
</tr>
<tr>
<td>Integrate applications cross-functionally</td>
<td>Eliminate delays and errors in filling customers’</td>
</tr>
<tr>
<td>Ease technology capacity constraints</td>
<td>orders for merged businesses</td>
</tr>
<tr>
<td>Improve IT architecture</td>
<td>Provide integrated IT support</td>
</tr>
<tr>
<td>Consolidate multiple different systems of the same type</td>
<td>Standardize procedures across different locations</td>
</tr>
<tr>
<td></td>
<td>Present a single face to customer</td>
</tr>
<tr>
<td></td>
<td>Acquire worldwide “available to promise” capability</td>
</tr>
<tr>
<td></td>
<td>Streamline financial consolidations</td>
</tr>
<tr>
<td></td>
<td>Improve companywide decision support</td>
</tr>
</tbody>
</table>

Table 1
Reasons for ERP adoption
appears to be more appropriate than Rosemann and Wiese approach for building balanced scorecards for ERP systems. However, van Grembergen’s approach requires building cascading balanced scorecards from the ERP systems level, to the IT department level, to the organization level in order to link the ERP balanced scorecard to the organizational business objectives. This puts the creation of ERP scorecard within the context of building the organizational balanced scorecard, which is a very complex and time consuming process. A more direct approach of building ERP balanced scorecards is needed that aligns ERP implementations and operations with strategic business objectives to maximize the value-added contribution of the ERP system to an organization.

In summary, our notion of ERP systems success is broader and more comprehensive than the ‘success’ concept used by Rosemann and Weise [8]. Building on Zuboff’s [9] notions we suggest that the success of ERP implementations and operations depends on the firm’s intention to use the ERP system to automate, informate or transformate the organization. In our view, organizations begin with the goal of automating business processes in a way that leads to seamless accumulation of consistent data across the organization, but they soon discover that ERP systems can be used to inform affected parties across the value-chain such that decision-making at all levels is vastly improved (informate). Furthermore, in order to effectively provide value-added services to stakeholders and compete in global markets, organizations need to be agile and flexible and capable of reengineering and transforming themselves to survive and thrive in today’s highly competitive markets. We will use a case study research method to build our theory for ERP scorecard [16].

### Table 2

<table>
<thead>
<tr>
<th>Questions for ERP performance</th>
<th>ERP implementation</th>
<th>ERP operation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial</strong></td>
<td>What is the detailed cost of ERP implementation?</td>
<td>What is the financial input necessary for achieving targeted performance level?</td>
</tr>
<tr>
<td><strong>Customer</strong></td>
<td>Does the ERP software efficiently support the individual needs?</td>
<td>What benefits derives the company from a certain level of performance?</td>
</tr>
<tr>
<td><strong>Internal process</strong></td>
<td>Does ERP software improve the internal business processes?</td>
<td>Are internal processes effective and efficient in assessing level of performance determined by customer perspective?</td>
</tr>
<tr>
<td><strong>Innovation and learning</strong></td>
<td>Is ERP software flexible enough to integrate future changes?</td>
<td>Does ERP system have enough potential for future customer needs?</td>
</tr>
</tbody>
</table>

### 3. The case organization and SAP implementation

The case organization used in this study is in the business of aircraft engine design, engine manufacturing, engine repairing and engine servicing. The company deals with both government and commercial aircraft engines business, and its design and repair facilities are distributed globally. The company’s manufacturing facilities are distributed in several states in the US, and engine servicing depots are located in Southeast Asia, Northern Europe and the United States.

The IT department consists of approximately 500 professionals distributed across three departments: business applications systems, software applications and IT infrastructure. The latter two functions are outsourced to a renowned global IT outsourcing company whose offshore software development partner is in India. The IT personnel of the organization work side-by-side with the IT outsourcing company’s employees, and the IT outsourcing company’s personnel who work with the case company are included in the headcount of about 500 IT professionals. The IT department is viewed primarily as a cost center by the organization and a service center by the IT department, based on Venkatraman’s [17] categorization; and IT investments are focused primarily on providing IT-enabled capabilities for existing business strategies.

SAP is being implemented using a phased approach, with a 4 year planned roll-out for each phase. A national consulting firm served as the SAP business process consulting partner. The SAP implementation goal is to have one ERP system on a single platform with no legacy investment at the end of 4 years. There were 900–1000 legacy systems operating at the case company, plus a host of home-grown local
applications. The SAP implementation for each phase was assigned to a specific executive owner from the appropriate business unit. A cursory description of the phases is presented to provide the background that the reader may need to understand the ERP scorecard sample metrics that were identified by the IT and business managers as success measures for their SAP systems.

3.1. Phase I (July 1999): initial site

The goal of phase I was to demonstrate a quick success, and develop a trusting working relationship among the different SAP implementation partners; namely, the organization’s IT group, the SAP business process consultant and the IT outsourcer. A newly acquired engine service depot was selected as the initial site for implementing SAP’s materials requisition modules for materials planning, procurement, warehousing and financials. Because the engine depot had no legacy systems in this area and most business processes were ad hoc and fluid, the implementation ran smoothly using the standard implementation methodology suggested by the business process consulting partner.

3.2. Phase II (October 1999): core finance

Since finance is the heart of ERP system, the company made a decision to implement the core financial models next. Following the SAP implementation textbook, each implementation of a core finance module was managed by the appropriate business partner. To avoid customization of SAP code, the company decided to adopt an out-of-box implementation strategy with standard configuration. The accounting functions of general ledger, cost controlling, fixed assets and accounts payable were implemented, along with the business warehousing function for decision making. The financial models were implemented globally. In February 2000, the organization upgraded to SAP 4.5 without any hitch.

3.3. Phase III (March 2000): warehousing and parts tracking

In phase III, the warehousing and parts tracking modules in SAP were implemented. The inventory tracking system is based on standard bar codes/scanner technology. First, the warehouses in a discrete location were converted; next, all the domestic warehouses were converted; and last, all international warehouses were converted.

3.4. Phase IV (May 2000): full materials requisition deployment at site 1

In this phase, the front-to-back supply chain was automated at the initial site. Full order processing, engine and parts management, labor and material accounting, logistics, parts disposition and invoicing modules were implemented.

3.5. Phase V (August 2000): production engine assembly

Full project management of engine production assembly was implemented in SAP. Order processing, engine and parts management, common labor collection, logistics and configuration management modules were included. This implementation allowed links with external suppliers via an Internet portal. A key feature is that the supplier cannot ship the part until the shipping label is printed, and the supplier cannot print the label until the assembly team at the depot is ready. More significantly, the need for custom SAP coding arose during this phase. That is, a part allocated for new engine production assembly in the warehouse should not be issued if it is needed for engine repair. Since standard SAP has no way to control this scenario, custom coding had to be done for logical split between new engine parts and engine repair spares parts. This is one example of why custom coding is necessary despite the philosophy of out-of-box SAP implementation strategy.

3.6. Phase VI (August 2001): full materials requisition deployment at site 2

The goal of phase IV was to deploy the full materials-requisition solution that was successfully implemented at the initial site to engine center sites 2 and 3. The presence of legacy systems at site 2 required extensive data cleansing work, hence, this phase was delayed. This implementation also highlighted the
need for more end-user involvement. The data cleansing work led to the development of extensive three-cycle testing methodology involving power users: (1) sunny day tests were conducted assuming that routine transactions were completed with no problems, (2) cloudy day tests were performed assuming that certain known problems arose during transaction processing and (3) regression tests were run to ensure that the quality of the application did not degrade with debugging. In addition, a new user training approach was developed. The organization also became independent of the SAP business process consulting firm during this phase because the standard SAP implementation no longer worked; that is, implementation processes had evolved and adapted to the needs and problems of specific circumstances of the organization. In addition, sufficient transfer of knowledge had occurred from the consultants to the organization, that the consultants were no longer viewed as value-added.

3.7. Phase VII (February 2002): materials requisition deployment at site 3 engine center

The lessons learned in phase VI enabled a very smooth deployment at the site 3 Engine Center.

3.8. Phase VIII (August 2002): component repair implementation

In this phase, the process of receiving an engine, giving it an overall inspection, tearing it down into modules, inspecting the modules, repairing parts or acquiring and replacing parts and assembling, testing and shipping the engine back to the customer became paperless. This resulted in significant efficiency gains with respect to labor and time.

3.9. Phase IX (October 2002): management of government funded programs

Government funded programs have distinctive requirements; for instance, a part ordered for a government project never belongs to the organization, therefore, the part is never considered as a company inventory item. This unusual feature and many more unique requirements were implemented in phase VIII.

3.10. Phase X (2003): deployment of the component repair modules to other repair facilities

The organization is now involved in Phase X, which involves deploying the component repair modules of SAP in all other globally located repair facilities.

This case organization is very happy with its ERP implementation efforts and outcomes. To understand how this organization is measuring the success of its ERP system, we interviewed the IT director and three functional area senior managers. These interviews revealed several outcomes that were impacted by the ERP system. As expected the ERP system has streamlined the business processes by linking cross-functional processes, reducing error rates, increasing information visibility and providing the case organization an infrastructure that is allowing it to better meet and accommodate new requirements and challenges. The company managers offered the following specific outcomes to justify their success claim of their ERP phased implementation.

- on time delivery of overhauled engines improved from less than 50–95%;
- on time delivery of spare parts improved from 30% to 90%;
- the timeliness and availability of information improved dramatically;
- the reliability and integrity of data improved noticeably;
- internal controls were tightened;
- work stoppages, caused by lack of parts on the floor, dropped from several per month to an average of one-half per month;
- enterprise-wide standardization of core finance modules now provides the same financial information to all the different stakeholders;
- the inventory availability rate increased from 60–70% to 95%;
- the cost of engine assembly process has been significantly reduced;
- improved customer satisfaction;
- the later phases of the ERP implementation were executed better than the earlier phases;
- the lessons learned from each phase are now captured, documented and managed across the enterprise;
refined training methods are enabling users to adapt to the system quickly and more effectively, mostly due to the innovative involvement of power users in the creation and delivery of training;

• transfer of implementation process knowledge from external consultants to company managers is a key critical success factor for effective implementation for later phases.

4. Case analysis and findings

Our interviews brought out that the SAP implementation in the case organization (1) streamlined the internal business processes, (2) required innovative training to ensure users could use the systems effectively, (3) impacted customer needs and (4) positively impacted the key financial parameters. We will discuss next the impact of these SAP outcomes and the eventual contributions of the SAP system to the strategic goals of the case organization.

4.1. The impact of streamlined internal business processes

Since the ERP system integrates disparate processes across the organization, the end result is more streamlined business processes and smooth and transparent flow of information. In the case organization, the smooth and transparent flow of information in the engine service centers improved the on-time delivery of engines from less than 50% to between 95% and 100%. Similarly, in the engine assembly process, work stoppages due to unavailability of parts dropped from several stoppages per month to an average of 1/2 per month. Also, the inventory is better managed now with on-hand-and-available rate improving from 60–70% to 95%. In short, the streamlining of business processes by the ERP system has drastically improved productivity and driven efficiency. Furthermore, the ability to access correct and consistent data in a timely manner has led to improved human resource planning, better investment spending and higher quality decision making.

4.2. The ERP system usage requires learning and training innovations

The end-user training process developed by the SAP business process consultants relied on the standard SAP business processes. The training materials were narrative, documented in very thick books and cumbersome. By phase III of the implementation, the organization realized that the training process was not effective because many interventions were required to get the users become reasonably proficient in using the new system. The organization developed a new innovative training process that required power users from each user groups to work with the new system for 4–5 weeks and help develop training materials for peers. A work-step instruction book with 10 pages of PowerPoint slides was developed for each module. Users were allocated to appropriate training classes where they sat in front of computer terminals in a classroom facilitated by the power user on selected production data to learn how to use the systems and its features. This new training process has been very effective and has replaced the old training process.

Another example of learning and innovation in the user domain involves the design and modification of ERP input and output screen for the hourly workers. Most of the hourly workers are not computer literate and the multiple screen user interfaces of SAP were challenging for these workers. The implementation team developed simplified task-driven screens for this audience.

4.3. The ERP system impacts customer needs

A common requirement in the engine manufacturing and service business is ad hoc requests for a spare part. This happens every time an airplane has engine problem and local diagnostics reveal a part failure that needs replacement. Prior to the deployment of the ERP system, there was no way to directly track and locate the exact warehouse in which the required spare part is located, hence, customers had to call each warehouse individually until the part was located. This process took a significant amount of time and the delay costs were considerable. Today however, the ERP system shows every warehouse where each spare part is located, and this allows the customer to select and order delivery of the part from the nearest warehouse, thus improving the delivery time on spare parts. Similarly, the implementation of the ERP system in the engine service centers has streamlined the engine overhaul process leading to improved engine turn-around time to
the customer. Thus, the impact of process efficiency in this case is improved customer satisfaction.

Another area that has impacted the customer is quality control. In the old, legacy-based system, employees had to complete a multi-page form which was then sent to data processing, where it was subsequently subcontracted for data entry. It would take 4–5 weeks to get the necessary reports and to conduct the root cause analyses. Today, quality control activities and related analyses are performed daily, leading to better attending to customers’ quality demands.

4.4. The ERP system impacts financial outcomes

The company also indicated that the cost of doing business has been dramatically reduced. The reduction of work stoppages, the timeliness of data availability and better controls have improved corporate performance and promoted labor efficiencies. Also, better inventory and supply chain management has resulted in decreased costs. Simultaneously, the ability to make accurate commitments to trading partners and improve turn-around time has increased the after market business, thereby resulting in increased revenues.

4.5. Linking ERP systems outcomes to business objectives

Our discussions with company personnel indicated that the initial decision to replace all of the legacy systems with an ERP system was primarily based on a cost–benefit analysis for automation. In other words, the implementation objective of the ERP system was to automate the business, which was expected to lead to a lowered IT budget, increased efficiency of workers, reduced input error rate and more timely availability of accurate and reliable information. However, once managers and other users learned more about the new ERP system’s capabilities, they recognized that improved information accessibility and visibility across the enterprise allowed them to make more effective operational, tactical and in some cases strategic decisions. This resulted in better manpower planning, enhanced inventory control, radical improvement of on-time delivery of overhauled engines, and on-time delivery of spare parts. Eventually, the consequential increase in customer satisfaction led to an unexpected change in business strategy, which was to increase the company’s market share in the after market parts and service business. This dialog revealed the potential contributions of ERP system on the strategic goals of the company. Fig. 1 illustrates how the ERP systems when combined with appropriate training in its use resulted in expected benefits of error reduction and efficiency in the order processing and order fulfillment processes that touch the customer. Later, they discovered that improved decisions in inventory management and manpower planning in these processes contributed to cost reduction, and proactive and timely service to customers increased customer satisfaction. The cost reduction contributed to increased profits and increased customer satisfaction contributed to increased sales and market share. Similar benefits-results chains can be developed to show the contributions of other streamlined processes to the achievement of strategic goals. The benefits-results chain notation of Fig. 1 is based on Boehm’s [18] idea of value-based software engineering.

5. Applicability of balanced scorecard framework for ERP systems

Thus, far our case study has illustrated the impact of ERP systems on the four dimensions of balanced scorecard. But, our ultimate goal is to identify key measures in each of these four dimensions that provide a holistic view of ERP success.

We viewed these examples of ERP success from the balanced scorecard frame and discovered, as Table 3 shows that the 14 success outcomes identified by the case organization managers fell into one or another of four categories of the balanced scorecard framework. Thus, this case study illustrates the potential applicability of balanced scorecard for assessing ERP success.

6. Derivation of a balanced scorecard based ERP scorecard

Although these examples of success measures in the four BSC dimensions suggest the applicability of the balanced scorecard to the ERP domain, they are quite incomplete in the sense there are many more measures in each of the four dimensions. In addition,
the granularity of these measures is uneven, and because a balanced scorecard is not just a compilation of all the measures it is not clear whether each of these measures should be included in a balanced scorecard. The objective of the balanced scorecard is to identify and define a parsimonious set of measures that enable management to understand the state of the organization in order to control and steer it. In other words, we need a framework that systematically guides in the identification and selection of the ERP success measures. We will now attempt to define an ERP balanced scorecard framework that will guide the identification and selection of key ERP success measures.

The search for a framework that aids in the identification and selection of ERP success measures led us to re-examine the goals of ERP in the organization. As alluded to in the earlier part of this paper that the decision to replace all the legacy systems with an ERP system was made by the CEO and the CIO, and apparently the case for the ERP system was made on cost justification of replacing the 1000 loosely connected legacy systems with an enterprise-wide system running on one platform.

Table 3
ERP success outcomes in the case organization

<table>
<thead>
<tr>
<th>Process dimension</th>
<th>Customer dimension</th>
<th>Finance dimension</th>
<th>Learning and innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average work stoppage per month</td>
<td>Percent on-time delivery of overhauled engines</td>
<td>Inventory availability rate</td>
<td>Learning from ERP implementation phases</td>
</tr>
<tr>
<td>Data Integrity</td>
<td>Percent on-time delivery of spare parts</td>
<td>Engine assembly cost</td>
<td>Implementation knowledge transfer</td>
</tr>
<tr>
<td>Internal controls</td>
<td>Customer satisfaction</td>
<td></td>
<td>Training method effectiveness</td>
</tr>
</tbody>
</table>
Thus, for this organization, the initial objective of the ERP system was largely to automate the business with one integrated system, and success was conceived in terms of reduction in the IT budget and the increased productivity and efficiency of the internal workers.

The business partners were assigned the responsibility to implement the components of the ERP system using the phased implementation approach described earlier. As the business employees learned the new system and in many cases new or revised business operations, the visibility of data across the whole business process opened up the opportunity for managers to make more effective decisions. Thus, the initial ERP objective of automating the business processes changed to more business-oriented objective of ERP system of improved management decision making.

In summary, the ERP implementation at the case company began with the goal of automating business processes in a way that could lead to a seamless accumulation of consistent data across the company. After workers and managers become comfortable with the new system, they discovered that ERP system also served to inform affected parties across the value-chain, thereby improving decision-making at all levels. The managers of the case company explicitly noted that the surprise benefit of the ERP system implementation was the impact of improved information visibility across the entire value-chain. Such visibility enabled better decision making across business processes and the ability to track engine parts in their global warehouses expanded the firm into after-parts business, leading to higher valuation of the company and addition of new customers with new needs. The ability of the new ERP IT infrastructure to accommodate these organizational transformations in a routine manner suggested to us that Zuboff’s [9] notion of transformate should be included to paint a more compete picture of how ERP systems can positively affect the ‘success’ of an organization. Thus, combining Zuboff’s three levels, automate, informate and transformate, with the four balanced scorecard dimensions of benefits generates a very useful 12 cells framework to explain, understand and identify the direct and indirect contributions of ERP implementations.

This new framework partitions the ERP implementation benefits into three levels. The automate level focuses on operational benefits of ERP systems, the informate level focuses on tactical decision making outcomes impacted by an ERP implementation, and transformate level looks at strategic impacts of ERP implementation. In Table 4 we define the goals of the ERP system in each of the 12 cells of our balanced scorecard based ERP benefits framework. These goals help to develop success measures by raising the key questions necessary to achieve those goals and assigning a metric to each question [19].

We will conclude this section with a discussion of the goals of the 12 cells of our ERP balanced scorecard.

6.1. Automate/process cell

The goal of the ERP system in this cell is to make the business processes efficient. A key process efficiency measure is the throughput of process. In our case study, if we look at the engine servicing process, a throughput measure is the average number of engines overhauled each month. Thus, in the construction of an ERP balanced scorecard the throughput of each business process served by the ERP is a potential success measure of an ERP system.

Efficiency of a process can also be measured in terms of reduction in input resources, often quantified in terms of removal of waste from the system. In our engine servicing process, reduction of work stoppage from several stoppages per month to just one-half per month is an example of efficiency measure. Since automation of a process implies that the worker is not productive when the system is down, the IT measures of system availability and system uptime become key measures in the ERP balanced scorecard. In summary, process throughput, process efficiency and systems availability/system up time are key metrics for measuring the success impact of ERP systems.

6.2. Automate/customer cell

The goal of the ERP system in the automate/customer cell is to meet customer needs more effectively. It should be noted that process efficiency achieved through automation might not automatically impact the customer positively. This cell is suggesting that for identifying success measures you need to understand the customer needs and check which of
those needs is directly impacted by the automation of the process. In particular, for those processes that touch the customer, the systems response time, such as meeting the commitment date, becomes a key measure in this cell. In our case study, the on-time delivery of spare parts, which improved dramatically after the implementation of SAP system, is an example of response time.

6.3. Automate/finance cell

The goal of the ERP system in the automate/finance cell is to reduce cost and improve ROI. In our case study, the justification for the ERP system was made on the anticipation that the cost of IT budget for current service level will reduce. This measure gets muddy because it is linked with the level of service. More appropriate cost reduction measures for ERP systems are the cost of executing the business process before the ERP systems and then after the ERP system.

6.4. Automate/learning and innovation cell

The goal of the ERP system in this cell is to make the employees competent users of the system. Thus, the quality and effectiveness of the training processes affects the employee ability to use the new/revised process and the new system, a success measure in automate/learning cell is training effectiveness. In our case study, innovative involvement of power users in the creation and delivery of training leading to refined training methods was offered as an example of success measure that fall in this category.

6.5. Informate/process cell

The goal of the ERP system in this cell is to help the employee and management make improved decisions. They can be operational, tactical or strategic. In our case study, several examples of improved decision areas were noted, such as man power planning, quality management, inventory management and supply-side

<table>
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<th>Table 4</th>
<th>ERP benefits framework</th>
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<td><strong>Process</strong></td>
<td><strong>Customer</strong></td>
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<td><strong>Automate</strong></td>
<td><strong>Operational benefits</strong></td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td><strong>Error/rework reduction; faster processing; consistent data; reduction in processing time; increase in throughput</strong></td>
</tr>
<tr>
<td><strong>Informate</strong></td>
<td><strong>Tactical benefits</strong></td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td><strong>Improved work scheduling; improved work assignment; improved access to information; improved quality management; improved control</strong></td>
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<tr>
<td><strong>Transformate</strong></td>
<td><strong>Strategic benefits</strong></td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td><strong>Technology changes; regulatory changes; competition changes</strong></td>
</tr>
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</table>
management. Appropriate measure can be created based on what questions the organization considers to be key. For example, in the inventory management area, inventory availability rates were identified as a measure of success.

6.6. Informate/customer cell

The goal of the ERP systems in the informate/customer cell is to improve customer satisfaction. There are several indirect measures to assess this, such as increase in repeat customer and meeting customer expectations. In more service oriented businesses, direct measures are customer satisfaction surveys.

6.7. Informate/finance cell

The goal of the ERP system in the informate/finance cell is to improve ROI by increasing revenues. In our case study, the ability of the organization to effectively address customer need for spare parts and meeting commitment dates for engine overhaul resulted in more than higher customer satisfaction but an expansion in the after market parts and engine over hall business leading to the acquisition of new service centers and more warehouses. In other words, the ERP system has impacted enhanced revenue opportunities and improved market positioning.

6.8. Informate/learning and innovation cell

The goal of the ERP system in this cell is to make the employees more competent decision makers. Once again the effectiveness of the training processes is the key success measure but the context of training goes beyond learning how to use the system to learning how to exploit data in the ERP data warehouse. It may also involve the use of modeling and decision support tools.

6.9. Transformate/process cell

The goal of the ERP system in the transformate/process cell is to facilitate business agility. Facilitating business agility means the ERP system can be adapted in a routine manner to new process requirements caused by changes in business requirements. In our case study, business agility was not tested but we have been observing the implementation of the Sarbanes-Oxley Act in the PeopleSoft financial module at another site. The implementation of the Sarbanes-Oxley Act in PeopleSoft financial module is an example of ERP system facilitating business agility.

6.10. Transformate/customer cell

The goal of the ERP system in the transformate/customer cell is the transformational capability of the organization to meet the new needs of the customers and the needs of new customers. This also includes strategic partnering with the customers. By strategic partnering we mean the organization goes beyond sharing risks and rewards to anticipating customer needs, shaping customer needs and adapting to new needs of existing customers. A hypothetical example is if the engine over hall process showed some stress faults in certain type and age of engines, the ERP system can help the organization to share this finding with all the other customers owning these engines and offer solutions to correct potential future problems.

6.11. Transformate/finance cell

The goal of the ERP system in the transformate/finance cell is to facilitate market valuing and growth. Financial measures in this cell are high market multiples, creating options through research and development and market awareness.

6.12. Transformate/learning and innovation cell

The goal of the ERP system in the transformate/finance cell is to facilitate continuous evolution and adaptation. The focus of training and innovation is on learning how to discover new markets and engage in continuous market evolution. Training moves from content learning to knowledge sharing.

7. Summary and conclusion

In this section we will summarize the value and contribution of this new ERP benefits assessment framework, called an ERP scorecard.
First, Booth et al. [7] noted that no analytic framework exists to examine the potential benefits after the ERP system is successfully implemented and put in use. The 12 cells ERP scorecard derived and presented in this paper addresses this gap in the ERP research literature.

Second, Davenport [11] observed that there are different types of benefits and some types are likely to arise before others. Specifically they suggested that improved transactional processes and common data appear to precede benefits associated with improvements in management and decision making. Our ERP scorecard makes Davenport’s observations explicit. The automate level and the informate level benefits of the ERP scorecard capture the improved transactional processes benefits and the improved decision making benefits, respectively. More significantly, the ERP scorecard goes beyond suggesting that there are two types of ERP benefits. Specifically, it introduces the transformate level benefits, shows the operational and tactical benefits in all four balanced card dimensions and provides goals that define the different types of benefits an organization can expect from ERP use.

Third, like Davenport, Markus and Tanis [4] and Markus et al. [20] also suggest that ERP benefits should be measured at different points in time. It is easy to see that the first benefits of an ERP system are those related to process productivity improvement, triggered by factors such reduction in errors, timely availability of consistent information, etc. As noted earlier that these soft improvements contribute to organizational measures, such as cost reduction, increased worker satisfaction and increased customer satisfaction. As the workforce becomes more familiar with the ERP software and its reach across functional boundaries, the benefits that result from improved tactical decision making become feasible. This reasoning suggests that informate level benefits can only occur after the organization has achieved automate level benefits. Theoretically, this ordering of benefits is valid but in practice we found that any point in time an organization is achieving informate or even transformate level benefits in one part of the organization and automate level benefits in another part of the organization.

In our case study, we found that ERP is a journey [21] with different levels of maturity in its use and goals in different parts of the organization. For example, the warehouses in our case organization are perfectly happy with automate and informate level benefits in terms of meeting customer needs proactively, improved tactical decision making, decreasing costs and increasing revenues, the organization saw an impact on the after market parts business. This led to a change in strategy and today the after market parts business is fetching 60% of the revenue of the case organization. We saw here the evidence of transformate level indicators.

Fourth, although the literature suggests that the balanced scorecard may be the appropriate approach for defining the success of ERP systems, only Rosemann and Wiese [8] have attempted to conceptually apply the BSC approach for managing ERP systems. As discussed in the literature review section, Rosemann and Wiese have a limited view of ERP system success. We demonstrated through the case organization that ERP systems impact all the four dimensions of balanced scorecard at the organization level, and thereby, they are capable of contributing to the business strategy of the firm. Our ERP scorecard shows that the success of ERP implementations and operations depends on the firm’s intention to use the ERP system to automate, informate or transformate the organization.

Fifth, the new ERP framework not only fills the gap in the ERP research literature, we also saw its immediate benefit to the case organization. For example, the case organization is very proud of its innovative and effective ERP training program. Our model brought out that their training program is designed to only address the automate-level benefits, and it needs to be enhanced extensively to effectively support the informate level and transformate level benefits.

In summary, our innovative integration of Zuboff’s [9] notions of automate, informate and transformate with the balanced scorecard dimensions into a complete and comprehensive ERP scorecard has generated a new methodology for identifying the success measures by analyzing the goals of each of the 12 cells for that organization. As we continue to operationalize this ERP scorecard at the firm level, we hope to develop industry specific patterns that can be quickly adapted for assessing the benefits of ERP systems.
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