How Firms Learn From the Uses of Different Types of Management Control Systems

Michael T. Lee, Boise State University
Sally K. Widener, Rice University

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We gratefully acknowledge the financial support of the IMA Foundation for Applied Research . We also acknowledge Infosol.com, whose support was instrumental in completing this project.

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EXECUTIVE SUMMARY

Many users of management control systems claim that a system's effectiveness in creating business performance resides in its ability to facilitate learning and decision making. Yet this does not explain why users of management control systems have varying levels of success in terms of business performance with these tools. Our IMA-sponsored research project[1] examines the following questions that relate management control system use, learning, and performance:

- How are management control systems used?
- How do organizations learn from management control systems?
- What uses of management control systems and styles of learning characterize high performing firms?

To answer these questions, we examine a set of management control systems that are in existence today: business intelligence systems. Business intelligence systems are computerized systems that identify, extract, and analyze business data (e.g., sales revenue by product and/or department and/or location). They facilitate learning and support decision making through the provision of various types of information. We examine three popular types of business intelligence systems and how they are used to facilitate learning in firms. The three types are: (1) dashboards and visualization, (2) query, analysis, and reporting, and (3) data management and data quality. We developed a survey to collect data that would help answer our questions.

We find that there are combinations of system types, system uses, and forms of learning that are associated with high firm performance. The results provide managers, users, and practitioners with a number of configurations of system uses and learning that can support increased firm performance.

1 Infosol.com was instrumental in helping us to pilot test the survey and obtain data. We gratefully acknowledge their support.

MANAGEMENT CONTROL SYSTEMS AND LEARNING

Prior research has shown that management control systems (MCS) can positively influence the development of learning in organizations (Widener, 2007). This line of research suggests that MCS can promote creativity, innovation, and/or learning from organizational mistakes (Simons, 2000). Still, there are also conflicting research findings that show that MCS can undermine the learning process (Argyris, 1977; Kloot, 1997). How can this be?

A potential explanation for these conflicting results is that there are multiple types and multiple uses of MCS (Widener, 2007; Malmi and Brown, 2009) as well as multiple forms of learning. Up until now, the complexities underlying these variations have not been fully recognized in the literature.[2] Our research project focuses on identifying the multiple types of MCS, multiple uses of MCS, and multiple forms of learning in high- and low-performing firms.

BUSINESS INTELLIGENCE SYSTEMS

We examine a set of MCS that are used by firms today: business intelligence systems. The traditional uses of these business intelligence systems have been in scorecarding and the measurement and control of performance in a firm's operational and financial areas. Managers and employees are monitored on operational and financial performance targets and correct deviations from targets. Business intelligence systems are, however, pushing beyond measurement and control. Through usage techniques, these systems help managers and employees to learn, seek opportunities, and take action to optimize people and processes.

There are three popular types of business intelligence system provided by Business Objects, a business intelligence software company owned by SAP, a large business management software company:

2 Although both Henri (2006) and Widener (2007) examine two usages of management control systems, both still only focus on one broad definition of organizational learning.

1. Dashboards and visualization;
2. Query, analysis and reporting; and
3. Data management and data quality.

In the following sections, we define each type of business intelligence system and classify them using a taxonomy from the research literature. Using the results from our survey sample, we report on how our survey sample has used these business intelligence systems. Furthermore, we identify the multiple forms of learning that result from the multiple types and uses of these business intelligence systems. Finally, we divide our survey sample into high- and low-performing firms and identify the types, uses, and learning that characterized the high-performing firms.

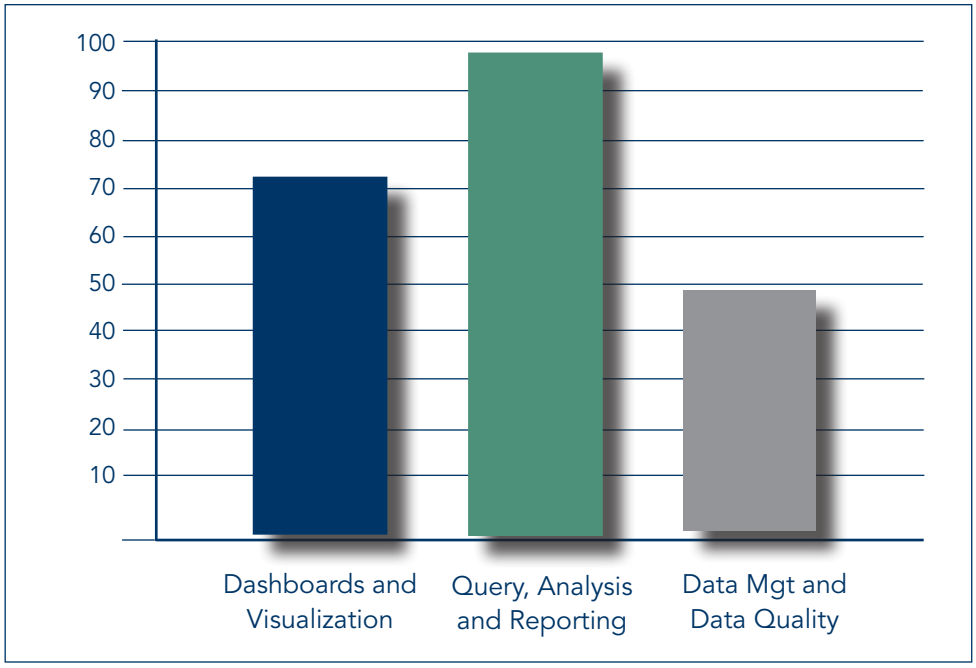
TYPES OF BUSINESS INTELLIGENCE SYSTEMS

Management control systems provide information to monitor, direct, evaluate, and compensate employees that support control strategies. They provide information related to markets, customers, competitors, and production processes, with a broad array of decision support mechanisms and controls that assist decision making. By design, MCS should influence employee behavior, thus achieving goal congruence.

Malmi and Brown (2009) propose an MCS taxonomy that classifies different types of MCS. Two distinct types of management control systems are cybernetic and planning systems. A cybernetic system reports information on critical factors. It focuses managers' attention on underlying drivers that must be achieved in order to realize the firm's intended strategy. Dashboards and visualization is a cybernetic system because it provides information on measures (e.g., financial measures, nonfinancial measures) and targets that allows managers to compute and monitor variations in performance (Malmi and Brown, 2009). To use dashboards and visualization, objectives are set, output is measured, output and objectives are compared, and corrective action is taken, if necessary. Control takes place after the event.

A planning system is an *ex ante* form of control. It sets out the goals of the functional areas of the firm to direct effort and behavior. These standards then enable coordination through aligning a set of goals across functional areas of the firm to ensure that they are in line with desired firm outcomes. In advance of the actual process taking place, predicted outputs are compared to the planned outputs. Any deviation between planned and predicted outputs will result in corrective action being undertaken in advance of the actual event. Two business intelligence systems—query, analysis, and reporting, and data management and data quality—provide planning capabilities to assist firms. The query, analysis, and reporting system enables users to interact with business information, pose questions, and find answers to those questions, leading to the formulation of goals across functional areas of the firm. It serves as a starting point to developing goals and making changes to goals before the actual process takes place. The data management and data quality system provides data assessments to check and ensure that data is accurate and complete. Users can also apply a series of rules or functions to transform the data so that the information that the data provides is useful for planning, controlling, and decision making. Perform-

Figure 1 – Uses of Business Intelligence Systems by Respondents



ing assessments and transformations routinely provides revised information that may impact planned and predicted outputs prior to the actual event.

OUR SURVEY SAMPLE

We collected 366 responses to our survey. After inspecting the data, we ended with 343 usable responses. As shown in Figure 1, almost all of these respondents (98%) use the query, analysis, and reporting system, while 71.7% use dashboards and visualization, and 49% use the data management and data quality system.

To address our three research questions, we focus on 150 (43.7%) of the respondents who use all three of the business intelligence systems.

Figure 2 shows that the vast majority (65.1%) of respondents work in information technology (IT), with 11.5% in manufacturing (Mfg), and 9.5% in accounting and finance departments (A&F).

Figure 2 – Area of Work by Respondents

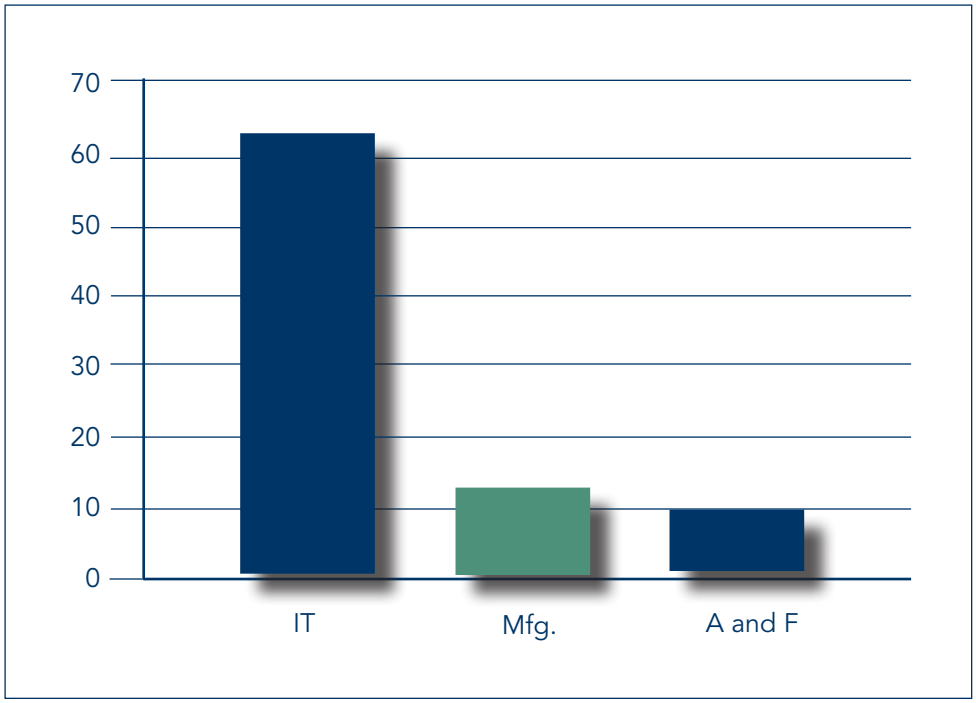
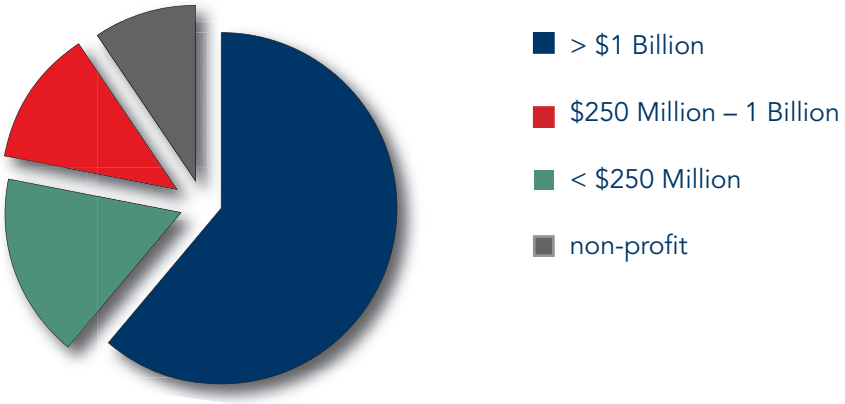


Figure 3 – Firm Size by Respondents



Our respondents were divided among directors/managers (25.3%), developers/architects (13.9%), system analysts (10.8%), business analysts (10.2%), and project managers (8.4%).

The size of the firms ranged from sales of less than $250 million (16.9%) to more than $1 billion (61.3%). Medium-sized firms (sales of $250 million to $1 billion) represented 12.7% of the sample. Some 9.2% of our respondents worked in nonprofit organizations. This is shown in Figure 3.

Our respondents also covered a range of industries, including healthcare (14.6%), financial services (12.3%), high-tech/electronics (12.3%), public sector (11.5%), professional services (11.4%), utilities (7.7%), insurance (6.2%), and retail (6.2%).

In summary, our survey sample exhibited the following characteristics:

- Our respondents used all three of the business intelligence systems. Most used the query, analysis, and reporting system.
- Directors/managers and team leaders from the IT department were the majority of respondents in the sample. Some responses came from manufacturing and accounting and finance departments.
- Our survey sample consisted mostly of large firms.
- A broad spectrum of industries was covered by our survey sample.

USES OF BUSINESS INTELLIGENCE SYSTEMS

In addition to various types of business intelligence systems (cybernetic and planning systems), firms may use these systems in various ways. Early research suggests that cybernetic and planning systems can be used to answer score-keeping questions such as "How am I doing?"; attention-directing questions such as "What problems should I look into?"; and problem-solving questions such as "What is the best way of doing the job?" (Simons, 2000). The levers of control framework (Simons, 2000) theorizes that the essence of these systems is to manage the inherent organizational tension between restriction by predictable goal achievement and motivation by creative innovation (Widener, 2007). Although there are four levers in the framework, it highlights that cybernetic and planning systems can be used either diagnostically or interactively.

Firms use business intelligence systems diagnostically to monitor and reward the achievement of pre-established goals. Diagnostic use is when managers use information as feedback to monitor predictable goal achievement. Managers focus on correcting deviations from preset standards of performance and monitoring negative variances. Firms set the system on "auto-pilot" and managers often pay attention to the information generated when it is out of tolerance. Thus, a diagnostic use requires less attention and dialogue between and across members of the workforce.

The interactive use of MCS occurs when top managers use the information from the MCS to expand opportunity seeking and learning throughout the organization. The information signals what top managers believe is important, this use therefore focuses attention and dialogue throughout the organization about the development of new ideas and initiatives. Typically, top managers generate information and then discuss and interpret the information with firm staff at different hierarchical levels in relation to the data, assumptions, and action plans. Interactive use of MCS is intended to expand opportunity seeking and learning throughout a firm. It is a forward-looking process that focuses attention and forces dialogue throughout the firm by reflecting signals sent by top managers. It stimulates the development of new ideas and initiatives that guides the bottom-up emergence of strategies derived from focusing on strategic uncertainties. Therefore, interactive usage is intended to help a firm search for new ways to strategically position itself in a dynamic marketplace.

Business intelligence systems have traditionally been used diagnostically. That is, the systems have been used in the measurement and control of performance in a firm's operational and financial areas. Managers and employees are monitored on operational and financial performance targets and correct deviations from targets. These systems are also being used interactively, however. They help managers and employees learn, seek opportunities, and take action to optimize people and business processes. In short, business intelligence systems use goes beyond the notion of diagnostics towards learning, opportunity assessment, and action that are a part of interactive use. These systems therefore lend themselves to both diagnostic and interactive use.

We expected to find four combinations of uses and types of business intelligence systems; that is, a diagnostic and interactive use of both the cybernetic (i.e., dashboards and visualization) and planning (i.e., query and reporting; data management and data quality) types of systems. Since a cybernetic system reports on critical success factors for a firm, the information can be used for tracking and monitoring variations in performance (diagnostically), and/or used to focus attention and create dialogue about new ideas, initiatives, and opportunities for its existing and future operations (interactively). Planning systems can be used for tracking and monitoring deviations between planned and predicted outputs (diagnostically). Any variations between planned and predicted outputs will result in corrective action before the actual event. It can also be used to explore information and pose questions for discussion that may lead to new goals across functional areas of the firm (interactively).

Upon inspection of the data we did find four combinations of uses and types of management control; however, the combinations did not match our expectations. We found that each of the type of business intelligence system (dashboards and visualization; query, analysis, and reporting; and data management and data quality) had a distinctive use that included both aspects of diagnostic and interactive use. The fourth combination focused on using the systems to question existing firm practices and spanned both cybernetic and planning systems.

Table 1 provides several interesting insights. First, the highest overall use at 5.52 (on a 7-point scale) occurs with query, analysis, and reporting. The mean uses on the individual items range from 5.38 to 5.71. Respondents use query, analysis, and reporting the least for frequent and regular discussions at meet-

Table 1 – Uses of Cybernetic and Planning Business Intelligence Systems

Average Scores (Scale: 1 = strongly disagree, 4 = neutral, 7 = strongly agree)	**CYBERNETIC USE:** Dashboards and Visualization	**PLANNING USE:** Query, Analysis, and Reporting	**PLANNING USE:** Data Management and Data Quality
Overall Type/Use	4.49	5.52	4.23
We use this function to track our performance.	4.55	5.71	4.37
We use this function to monitor variations with our performance.	4.41	5.61	4.31
We use this function to focus on critical success factors for our workplace.	4.49	5.35	4.18
Our top management regularly uses information from this function.	4.51	5.58	4.22
The information from this function is discussed regularly at meetings throughout our workplace.	4.44	5.38	4.11

ings and the most to track performance. Second, the next highest overall use at 4.49 occurs with dashboards and visualization, followed by data management and data quality at a use of 4.23. Third, it is interesting to note that respondents agree that all three systems are used the most for tracking of business performance, although the levels range across systems. Finally, respondents generally agree that all three systems are used the least for more interactive types of uses such as in frequent and regular discussions at meetings.

Table 2 – Questioning: Mixed Type of Business Intelligence Systems

Average Scores (Scale: 1 = strongly disagree, 4 = neutral, 7 = strongly agree)	QUESTIONING: MIXED TYPE
Overall Type / Use	4.23
We regularly question the information from the Dashboards and Visualization function.	4.09
We regularly question the information from the Query, Analysis, and Reporting function.	4.73
We regularly question the information from the Data Management and Data Quality function.	3.94

Table 2 shows a fourth combination of type and use of system with a focus on one other use–that of using the information to question what is going on—and both types of systems—cybernetic and planning—since it crosses all three specific business intelligence systems. Questioning query, analysis, and reporting scored most highly, while questioning the information from data management and data reporting scored the lowest.

We can summarize our observations of the types and uses of business intelligence systems as follows:

- Each type of business intelligence system is used in both diagnostic and interactive ways.
- We find that the pattern of use varies by specific systems and not by the type of system (cybernetic versus planning).
- We cannot generalize findings from one planning system (query, analysis, and reporting) to another planning system (data management and data quality).

LEARNING

Firms learn in order to change to fit their environment. The ability to learn is a capability that can be either adaptive or generative (Kloot, 1997). When the capability enables a firm to carry on its existing policies or achieve its objectives, it is known as adaptive or single-loop learning (Argyris, 1977). The prevailing strategies, structures, and actions continue where only adaptations to operating policies are made.

When learning incorporates not only detecting errors but also questioning underlying policies and goals, this is known as generative or double-loop learning (Argyris, 1977). Generative or double-loop learning resolves incompatible organizational norms by setting new priorities or restructuring norms, and creating a new operational paradigm.

Empirical research provides conflicting evidence on the relations between MCS and organizational learning. Henri (2006) finds a significant negative relationship between the diagnostic use of the performance measurement system and organizational learning and a significant positive relation between the interactive use of the performance measurement system and organizational learning. In contrast, Widener (2007) finds a significant positive relation between the diagnostic use of the performance measurement system and organizational learning. Her research does not find a significant relation between organizational learning and the interactive use of organizational learning, but she does find that the two uses of the performance measurement system are related.

In line with expectations, our sample revealed two forms of organizational learning. First, we found a type of learning that focuses on adaptations to existing operations. After learning about a problem, it is usual for the firm to search for a solution within its existing operations. The firm's management supports learning efforts that are most often limited to existing operations.

Second, we found a learning type that suggested changes to existing operations. That is, when searching for a solution to a problem, it is usual for the firm to challenge existing operations. The firm's management supports learning efforts that consistently challenge existing operations. These learning types are consistent with the research on organizational learning that suggests that there are two forms.

In this project we hope to shed insights on some of the conflict in the literature by linking the four combinations of uses of systems that we have found (dashboards and visualization; query, analysis, and reporting; data management and data quality; and questioning) with adaptive and generative learning.

CONNECTING USE OF SYSTEMS WITH LEARNING

Table 3 takes the four combinations of uses and types of business intelligence systems and calculates the correlation between them and the type of learning in our sample. Correlation measures theoretically range from -1.0 to 1.0 inclusive and reflect the extent to which the type and use of system functions and learning are interconnected. Positive signs show that they are interconnected in the same way, while negative signs show that they are interconnected in the opposite way. The larger the positive or negative correlation measure, the more interconnectivity between them.

Table 3 shows that the use of dashboards and visualization and query, analysis, and reporting are more correlated with generative learning than with adaptive learning. At the same time, the use of data management and data quality is more correlated with adaptive learning than with generative learning.

Table 3 – Correlations Between Uses of Systems and Learning

	Adaptive Learning	Generative Learning
Dashboards and Visualization	0.188	0.396
Query, Analysis, and Reporting	0.216	0.279
Data Management and Data Quality	0.239	0.219
Questioning	0.231	0.212

The highest correlation is between the use of dashboards and visualization and generative learning. While the table establishes that there is a positive relationship between uses and types of systems and types of learning, the results do not provide any information about which combination of use and type of business intelligence systems and learning are associated with high-performing firms.

USE AND TYPE OF SYSTEMS, LEARNING AND FIRM PERFORMANCE

To find out which combination of use and type of business intelligence systems and learning are associated with high-performing firms, we analyzed every combination of high/low levels of the four combinations of use and type of business intelligence systems (dashboards and visualization; query, analysis, and reporting; data management and data quality; questioning) and high/low levels of the two types of learning (adaptive learning, generative learning). We show the average performance from each combination. High levels of use and learning were those firms that responded above the median level, and low levels of use and learning were those firms that responded below the median level.

Table 4 – Uses and Learning with Average Scores of Internal Business Process Performance

Average Scores for Achieving Learning & Growth Outcomes*		Dashboards & Visualization Use		Query, Analysis, & Reporting Use		Data Mgt and Data Quality Use		Questioning Use	
		Low	High	Low	High	Low	High	Low	High
Adaptive Learning	Low	5.03	5.30	4.83	5.73	5.01	5.43	5.00	5.27
	High	5.22	***5.84***	5.30	5.75	5.46	5.79	5.59	5.52
Generative Learning	Low	4.66	5.09	4.75	5.03	4.78	5.01	4.70	4.91
	High	5.71	5.81	5.41	***5.95***	5.70	5.89	5.87	5.69

* Scale: 1 = strongly disagree with achieving internal business process performance, 4 = neutral, 7 = strongly agree with achieving internal business process performance

We define firm performance as the measures that are directly affected by the learning of our firms. High performance results if learning leads the firm toward achieving its operational process goals. These goals include timely product and service delivery as well as customer relationship process management that minimize product and service returns and complaints. We describe this outcome as internal business process performance. Table 4 shows the 32 high/low combinations of uses and types of systems, and types of learning with the average score that respondents provided for internal business process performance in their firms. It shows that that the highest internal business process performance, highlighted in bold, is obtained when firms use query analysis and reporting with generative learning (an average score of 5.95 out of 7), and when firms use dashboards and visualization with adaptive learning (an average score of 5.84 out of 7).

High performance is also obtained if the firm invests in its people, technology, and environment to support continuous improvement and value-creation

Table 5 – Uses and Learning with Average Scores of Learning & Growth Performance

Average Scores for Achieving Learning & Growth Outcomes*		Dashboards and Visualization Use		Query, Analysis, & Reporting Use		Data Mgt and Data Quality Use		Questioning Use	
		Low	High	Low	High	Low	High	Low	High
Adaptive Learning	Low	5.32	5.97	5.29	6.22	5.43	5.99	5.54	5.68
	High	5.86	***6.34***	5.85	6.28	6.10	6.28	6.04	6.12
Generative Learning	Low	5.10	5.67	5.16	5.69	5.26	5.40	5.28	5.23
	High	6.07	6.39	5.94	6.42	6.14	***6.46***	6.26	6.29

* Scale: 1 = strongly disagree with achieving internal business process performance, 4 = neutral, 7 = strongly agree with achieving internal business process performance

strategies. Known as learning and growth performance, it provides a foundation for firms to build strong decision-making capabilities, business agility, and operational excellence, which ultimately lead future financial performance for their firm. Table 5 shows the 32 combinations of uses and types of systems and types of learning with the average score that respondents provided for learning and growth performance in their firms. It shows that that the highest learning and growth performance, highlighted in bold, results when firms use data management and data quality with generative learning (an average score of 6.46 out of 7), and when firms use dashboards and visualization with adaptive learning (an average score of 6.34 out of 7).

In summary, we observe the following about uses and types of systems and types of learning for high-performing firms:

- Firms with high internal business process performance use dashboards and visualization for adaptive learning. Users see the critical success factors for a firm, and the information is used to monitor variations in performance and focus on improvements for existing operations.
- Firms with high internal business process performance also use query, analysis, and reporting for generative learning. Users interact with business information, pose questions, and find answers that lead to the development of new ideas that challenge existing operations and serve as a starting point for new alternatives and opportunities for the firm.
- Firms with high learning and growth performance use dashboards and visualization for adaptive learning. Users track the performance of firm employees and resources to targets and correct deviations that might affect existing operations.
- Firms with high learning and growth performance use data management and data quality for generative learning. The results suggest that users' regular assessments of and transformations to firm data provide revised information that often challenges the existing operational regime. It provides the firm with ideas about new initiatives that can support future performance.

- The use of business intelligence systems coupled with organizational learning is beneficial for achieving high performance on both internal business performance and learning and growth performance, but relatively more important to the achievement of learning and growth performance.

CONCLUSION

Our research has shown that the varying levels of performance and success from management control systems—specifically business intelligence systems—can be explained by the types, uses, and learning that come from the information that systems provide. It is often stated that it is not the systems that create firm performance and success; rather, it is the ability of a firm to use it and learn in unique ways. The results of this research project provide support for this statement. This research project specifically uncovers some of the answers behind the types of system uses and learning that can provide firms with the ability to learn, grow, and improve their business processes. These results provide managers, users, and practitioners with a number of configurations of system uses and learning that businesses can emulate.

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