



Business Intelligence and Organizational Decisions

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ABSTRACT

The focus on transactional systems in the earlier decades of information management is beginning to shift toward decisions. In order to study the relationship between information and decisions, the author interviewed 32 managers in 27 organizations where an attempt to use information to support decision-making had been made. A framework involving three different relationships between information and decisions is introduced: loosely-coupled, structured human, and automated. It is suggested that loosely-coupled information and decision environments, while productive for information providers, may require too much knowledge on the part of information users to be effective. A four-step process for bringing information and decisions in closer alignment is also advanced.

Keywords: Business Intelligence, Decision Automation, Decision-Making, Decision Support

INTRODUCTION

For most of the five-decade period beginning in the mid-1950s, the primary focus of information systems has been on automating core business processes. The era began with custom-developed narrow-purpose applications and concluded with broad enterprise system packages provided by external vendors, but the purpose was the same: develop control and efficiency over processes by automating and capturing information from key business transactions. Whether a general ledger entry, a customer order captured, or a vacation balance debited, the transaction has been the primary unit around which this world revolved.

By now, however, many organizations have mastered basic transactions, and are attempting to use the accumulated information from transaction systems to optimize decisions about the management of the business. From the early 1970s (Gorry & Scott-Morton, 1971), the idea was that better information would lead to better decisions and better ways of managing organizational processes. Whether this idea was called decision support, executive support, online analytical processing, or business intelligence (Power, 2007), there was always another goal waiting to be achieved. Because organizations' efforts and attentions were being spent on automation, to improve decision-making was never the primary focus. Today it has taken center stage. Business intelligence applications have become the top spending

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priority of corporate information technology organizations (Gartner, 2009).

If the goal of better information and better analysis is ultimately better decisions and actions taken based on them, organizations must have a strong focus on decisions and their linkage to information. Businesses need to address how decisions are made and executed, how they can be improved, and how information is used to support them. And they must look at all types of decisions: from strategic planning decisions made by senior management to every day operational decisions made by employees on the front line, or automated by back end systems.

There are obvious benefits to improving decision processes. Many organizations suffer from poor decision processes and outcomes. There is a growing body of knowledge on optimal decision processes and decision biases to avoid (Hammond, Keeney, & Raiffa, 1998; Garvin & Roberto, 2001), but it is often ignored or misapplied within organizations. Information that is available to inform decisions isn't used, or information is captured and managed that is unsuited for decision purposes. Information is valued and analyzed differently across different contexts (Tversky & Kahneman, 1974.) Decisions frequently take too long to make (Eisenhardt & Brown, 1998), and organizations lack clarity on who should make them (Rogers & Blenko, 2006). In assessing decision processes we hardly know the extent of the problem and the potential benefits, for few organizations identify, assign clear responsibility for, or track the results of their key decisions.

A STUDY OF DECISIONS AND INFORMATION

In this article I describe a study of attempts by organizations to improve decision-making through the use of information, among other interventions. Using telephone interviews in the second half of 2008, I spoke with 32 managers in 27 organizations about specific initiatives their organizations had undertaken

to improve decisions or decision processes. In each interview I asked about why the initiative had been undertaken, how the decision process varied before and after the intervention, and what steps were taken to provide the decision process and decision-makers with better or more trusted information. The research sites were selected based on press accounts of decision-oriented business intelligence applications, or references from business intelligence vendor personnel.

My intent was to understand how information is being applied to improve decision-making in a broad range of contexts. A list of the decision types and organizational contexts is provided in Exhibit 1. Most of the decisions listed are made frequently and involve core business processes of the organization. I sought out such core processes because it seemed that they would be the most likely to be the subject of initiatives to supply information for decisions.

While most of the managers interviewed were comfortable with talking about attempts to bring about better decisions, the topic was not yet "top of mind" in most companies. It was clear in the discussions that most firms had not focused consciously on better decisions as an area for business improvement. Some had not initially viewed their efforts as decision-oriented; this was true, for example, at a testing and research firm, which was attempting to improve its new product development processes. The manager interviewed stated, however, that the key issue in the process was making decisions about which products to develop.

There were some exceptions, however, to the "invisibility" of decisions. Two large banks, for example, had created "decision management" groups that focus particularly on analytical and quantitative decision processes. One major consumer products firm had renamed its IT organization "Information and Decision Solutions," and the organization contains substantial numbers of analysts who assist decision-makers with analyses and fact-based decision processes. While these organizations are moving toward a stronger

Figure 1. Types of decisions studied

1. Supply chain and financial decisions in electronics distributor
2. Credit and risk decisions in a money center bank
3. Marketing and performance management decisions in a fast food restaurant chain
4. Performance management and supply chain decisions in a vehicle manufacturer
5. Merchandising and loyalty decisions in a retail department store chain
6. New product development decisions in a testing and research organization
7. Credit and risk decisions in a consumer finance company
8. Energy project credit decisions in an energy finance company
9. Real estate finance decisions in a commercial real estate financing company
10. Sales decisions in an IT product and service firm
11. Retail financial services decisions in a banking and insurance firm
12. Claims and disease management decisions in a health insurer
13. Project estimation decisions in a defense contractor
- 14 and 15. Student performance decisions in two different urban school districts
16. Pricing decisions in an industrial equipment firm
17. Physician drug ordering decisions in an academic medical center
18. Critical care decisions in a hospital
19. Logistical decisions in a trucking firm
20. Pricing decisions in a carpeting manufacturer
21. Financial and disease management decisions in a health insurer
22. Organ donation decisions in an organ sharing network
23. Student performance decisions in a public university
24. Small business insurance underwriting and delivery in a major insurance firm
25. Oil drilling decisions in a mid-size integrated oil company
26. New greeting card decisions at a greeting card company
27. Automobile financing decisions in a sales and financing company

focus on decision-making, most do not seem to have broad agendas in place for connecting information and decisions in general, though they may have particular decision emphases such as greater use of analytics or automated decisions.

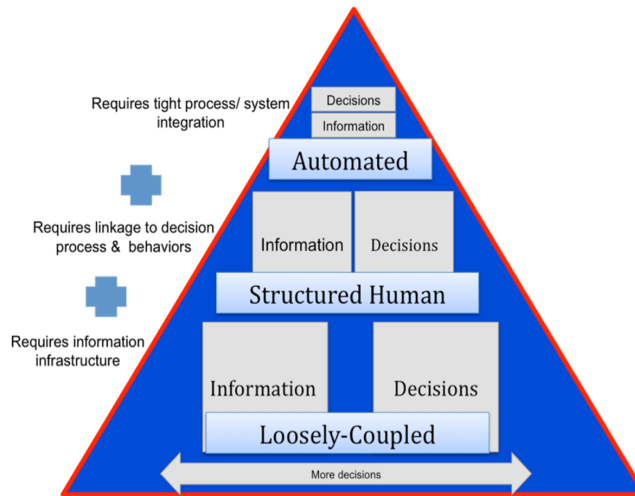
Linking Decisions and Information

How do organizations ensure that decisions are made on the basis of the best possible information, and that the right information is gathered and analyzed to support decision processes? In the research interviews I discovered at least three different levels of relationship between information and decision-making, each of which were present in the organizations interviewed for this study (Exhibit 2). The primary variable describing differences between the levels is the degree of structure in the decision, which

has appeared frequently in the business intelligence and decision support literature (Simon, 1960).

Loosely-Coupled Information and Decisions

Perhaps the most common approach to linking information and decision-making is to loosely couple the two. That is, organizations often make information broadly accessible to analysts and decision-makers for application to decisions, along with tools to manipulate and display the information. The information usually involves a particular business domain—finance, marketing, sales, or overall performance management, for example. However, it is intended to inform a range of possible decisions, and the actual use of the information for any particular decision is voluntary and based on individual initiative.

Figure 2. Three approaches to linking information and decisions

There is no monitoring of what information is used for what decisions, either before or after decisions are taken.

This loosely-coupled approach would characterize most organizations' approaches to business intelligence, or what was previously called "decision support." Data suitable for analysis and decision-making is extracted from transaction systems, and made available in a data warehouse or mart. Standard reports are produced, perhaps in easier-to-understand "scorecard" or "dashboard" formats. The appeal of this approach is that providers of information can supply it without regard to difficult and sensitive issues such as managerial psychology, organizational politics, and decision rights. In such decision environments, more structure or automation may not be appropriate or necessary. In this model it is not the task of the information provider (nor anyone else) to ensure that the decision is informed by the information or made well. Also appealing is that an information infrastructure can support a variety of decisions, which is productive and efficient for information providers.

However, while it does not directly address managerial decision processes, this loosely-coupled approach still presents many

informational challenges. In order to provide information suitable for decision-making, information must usually be integrated from multiple source systems and of high quality. Organizations also struggle with developing a "single version of the truth," so that information for decisions is consistent across the organization. It is easy for multiple versions of reports and data entities to proliferate across large, complex organizations.

I found several examples of this loosely-coupled approach in the study, and others are common throughout the business intelligence literature (Howson, 2007). For example, a regional health insurer created a "Financial Data Mart" to support a variety of financial decisions. The data mart was supplied with high-quality data on operations, product utilization trends, and financial results across the organization. Considerable efforts were expended to ensure "one version of the truth." Training was provided on how to use the system and how to access commonly-used reports and data cubes. The IT organization is of the impression that the primary users were much more able to create and apply reports that informed their decisions. Of course, since the specific decisions to be made from the data mart were not directly linked, the value

to improvements in decision-making remains impossible to calculate.

Other examples of this sort of decision/information relationship in the study included a student performance analysis and reporting system in an urban school district, and a somewhat broader business intelligence system at a large university. Both were focused on getting a better understanding of student performance; the university's system also addressed research grants, financial management, and human resources. Both were viewed as initially successful by the managers interviewed, and they required similar types of effort and investment as that of the health insurer. The urban school district experienced a decline in usage after the superintendent, the system's primary advocate, left the district. The university's most effective users were in a school where the dean was a strong advocate and user of the system.

As with the university and the school district, making these loosely-coupled decision environments work requires much more than simply making information available. Firms that had successfully improved decision-making described such approaches as a strong alignment between IT organizations and business units, approaches to developing the capabilities of users, and clarity on the business objectives of data warehouses and marts.

Structured Human Decision Environments

Some organizations interviewed had a narrower focus on particular decisions, but tried to create an overall decision-making environment that went beyond just establishing an information infrastructure. In this approach, the decision at issue is still made entirely by human managers or professionals, but specific efforts have been made to improve targeted decision processes or contexts by determining the specific information and other process resources needed to make better decisions faster.

The advantage of this approach is that these additional efforts created a stronger linkage between the information and the relevant

decisions, making it more likely to be used effectively. The challenges of this approach relative to the loosely-coupled one are its narrower focus on particular decisions, and the additional effort needed to create the decision environment. If the decision is an important one for organizational success, however, it may be worth the additional effort.

The type of additional support for decision-making varied widely across different examples in the study. In some cases analytical tools and capabilities provided the additional decision support, as in the case of pricing decisions at an industrial equipment firm; marketing and performance management decisions in a fast food restaurant chain; and merchandising and loyalty decisions at a retail department store chain. In the industrial equipment pricing example, salespeople were provided with analysis yielding a target price, a floor price, and a ceiling price based on analysis of previous sales and segmentation of the relative differentiation of the product being sold. At the fast food restaurant, randomized testing analyses were used to support new product marketing decisions, and econometric models provided explanations of which factors drove changes in weekly sales results. At the retail department store chain, predictive models of sales for particular brands were used to order merchandise for stores and regions. The use of such analytical approaches is an increasingly common feature of information-rich business environments (Davenport & Harris, 2007; Ayres, 2007).

However, in all three examples, analytics were not the only approach to improving the decision environment; there were also investments in establishing accurate, trusted information, along with a focus on organizational and behavioral techniques being employed. At the industrial equipment manufacturer, the company also felt the need to create new divisional pricing manager roles to ensure that salespeople understood the new pricing approaches and adopted them successfully. At the fast food restaurant, the Chief Information Officer employed principles from cognitive science research to maximize the likelihood that

executives would notice and understand key information. At the retail department store chain, information providers worked closely with early adopters of the new decision approach to identify ways to spread the use of the approach to less analytically-oriented merchandisers. And in all three cases, an information infrastructure was put in place with a particular focus on delivering the right information needed to support improved decision making.

A second decision environment at a different urban school district provides a clear example of the difference between loosely-coupled and structured human decision environments. At the first district with a loosely-coupled information and decision environment, the district supplied a data warehouse and business intelligence tools and some training opportunities, and expected principals and teachers to use the system on their own. At the second school district, the same types of tools were supplied. However, the district also created an “inquiry team” in each school. The inquiry teams each included 3 to 6 personnel—primarily teachers, but also the school principal. One team member is designated as an expert on the data and the tool set. The teams’ goal was to help school personnel define decisions and use the data and the tools to address them. District personnel report a higher degree of use and value for the system and data than in the first district that did not employ an equivalent to inquiry teams.

In other cases, organizations employed tools to provide additional structure around the decision process. At an energy finance company, an analyst interviewed senior executives to understand the factors they used in making financing decisions (Venditti, Peterson, & Siegel, 2007), and developed a model of the factors they employed using conjoint analysis (an analytical technique usually employed to understand customer preferences in marketing). While senior executives still actually make the decisions, the model has been very helpful to less experienced employees in preparing their financing proposals, and research has shown that decisions made using the factors uncovered in

the analysis are substantially more successful than those made with unaided experience and intuition.

At a truck manufacturer, decisions around performance management, supply chain and other operational issues were incorporated into a broader context. The company had adopted the A3 problem-solving approach as used successfully by Toyota (Dennis, 2006). The approach structures a set of problem resolution and action steps on two sheets of paper (A3 size in Japan). The approach ensures that information and decisions result in improved business performance. A greeting card company used considerable market research-based information, and a decision-structuring framework involving customer value, to assess whether a new line of lower-cost greeting cards provided sufficient value to customers. The framework represents customer value as a combination of five factors: equity, experience, energy, product and money.

Technology also provides support for these structured human decisions. Scorecards such as the “balanced scorecard” (Kaplan & Norton, 1993) and specialized information displays provide just the information needed by decision-makers, and no other. Recommendation systems based on algorithms or rules provide a recommended decision, but in these types of decisions they can usually be overridden by human decision-makers—as they were by physicians in an online physician ordering system in an academic medical center (Davenport & Glaser, 2002).

Given the breadth of the actions and tools that organizations adopt to better connect information and decisions and the challenges of addressing managerial behavior, this approach can’t be adopted for all decisions. The decisions selected for this sort of intervention must be particularly critical to organizational success. That is, they should involve strategic issues or important everyday decisions that drive business performance. With such interventions, however, the link between information and decision-making may be much tighter on average.

Automated Decisions

The closest linkages between information and decisions usually come when decisions are made by computer (Davenport & Harris, 2005; Taylor & Raden, 2007). When it is critical for information to be applied to a decision in a structured, formulaic fashion, the answer is often to employ automated decision systems. While the majority of press and visibility came to artificial intelligence and expert systems two decades ago (Kurzweil, 1990), many firms have quietly implemented more straightforward automated decision-making in a variety of business domains. In order to optimize operational decision-making, companies have embedded decision rules and algorithms into key business processes. In doing so, many have achieved greater speed, decision accuracy, and better customer service. While human experts, of course, design the system in the first place, with automated decisions they are not the primary decision-makers, and usually come into play only in handling exceptions.

Automated decision-making systems are not a new idea—they first took hold, for example, in “yield management” systems in airlines that made automated pricing decisions in the early 1980s (Ingold, McMahon-Beattie, & Yeoman, 2001)—but the applications for the idea are expanding significantly. After yield management, automated decision-making then became pervasive in the financial services industry, and is still most common there. In investment banking, these systems are behind the rise of program trading of equities, currencies, and other financial assets. For most consumers, the primary impact of automated decision-making is in the realm of credit approval. Credit scores are used to extend or deny credit to individuals applying for mortgages, credit cards, and other forms of debt. Though credit scoring has been criticized for being overly simplistic, it has certainly made the process more rapid and efficient, and there is no longer any doubt that credit score information is being applied to decisions that it can inform.

In this study, the automated decision activities were at two large banks, a large, privately held automobile sales and financing firm, and a large property and casualty insurance firm. All four organizations had institutionalized the process of developing and using automated decision systems. The insurance firm had begun using the approach on individual-level underwriting decisions, but had extended it to more complex small business policies. The company also built a special portal for its agents to use in entering data from the system and receiving results. The banks with automated decisions were primarily focused on automated credit and lending decisions. A large automobile leasing and financing firm was reengineering several of its business processes for automobile financing, and using automated decisions to improve efficiency and effectiveness of recurring financing decisions.

Again, in all four cases, there were significant investments made in the underlying information infrastructure. As decisions become automated, it becomes increasingly important to ensure that the information used is complete and accurate since there is no human involved for fact checking.

Of course, the development of automated decision systems is time-consuming and expensive. Firms must be very selective in deciding which decisions to automate. The decision process must be sufficiently structured and reducible to rules or algorithms, and a complete and direct linkage to all of the information needed must be created. There must also be frequent review of the decision rules or algorithms to ensure that they continue to produce the right decision outcomes. The automobile leasing and financing firm has a clear set of criteria to identify the processes that are most likely to benefit from automated decisions, and is committed to reviewing them frequently for needed revisions. The firm also integrates multiple information technologies to support the reengineered processes, including a workflow system for coordinating process flow, and a rules engine to store and execute business rules. Despite these challenges, automated

decision-making provides the closest possible link between decisions and information, and for this reason it is likely that they will continue to grow in popularity and effectiveness.

A Process for Connecting Decisions and Information

Given these three options for relating decisions to the information that informs them, organizations can follow a process for establishing and maintaining the connection. The process may vary somewhat with the particular decision/information linkage that the organization follows. While no organization specifically followed each of these steps in this order, a logical process can be inferred from the organizations interviewed.

Step 1: Strategic Focus on Key Decisions

Since connecting information and decision-making often requires a major investment of resources, it's important to ensure that any decision selected for intervention is actually important to the organization's strategy and performance. Therefore, a reasonable first step is for an organization's executives to discuss the strategy and determine what decisions are important to its successful execution. It may not be necessary to select decisions that are the most important of all, but no organization should waste time and energy on decisions that don't matter. And at least in retrospect, the choice of decisions for intervention often seemed obvious in the examples surveyed.

For example, a European financial services company with major business units in life insurance and banking concluded that it needed to become closer to its customers and to offer a more integrated range of financial services to them. Its management team decided that decisions around which products to offer which customers were critical to its strategy. After identifying the decision, the company embarked upon a series of efforts to pull together the information environment that would make an

integrated view of customers possible. Better decision-making by customers was also a goal, in that the new online environment would make it possible for them to see all of their holdings in one place.

The academic medical center discovered in the 1990s that it had unacceptably high levels of medical error. The organization's leaders decided that a key decision process was that in which physicians decided which drugs, tests, treatments, and referrals to administer to patients. This process, and information systems that address it, is known in the health care industry as "physician order entry." The importance of the decision to the institution's primary mission of better patient care is illustrated by the successful result of the order entry intervention: a 55% reduction in "adverse drug events" (Bates et al, 1998).

Organizations that do not address this strategic step first in their attempts to provide information for decision-making face a key risk. They may end up building information environments that don't help decision processes in business-critical areas. They may not be able to determine whether their efforts were worth the investment of money and time. Still, there are many organizations, including some in this study, that had embarked upon substantial information provision projects without any strategic clarity about what particular decisions they support.

Step 2: Information Provision

Given an important decision that's key to an organization's strategy, organizations must begin to provide information for it. In loosely-coupled relationships between decisions and information, this is appropriately the second step in the process; if the information and the decision are more closely coupled (in structured human decision processes or automated decisions), it may be more appropriate to first undertake Step 3 below involving decision design. The order in which information provision and decision design take place also varies by the amount of time it's estimated to take to make informa-

tion available to the decision. The provision of information may lead to the development of a data warehouse, a more focused data mart, or a specific analytical application. Either way, the accuracy and completeness of information will have a direct impact on the ease and effectiveness of the following steps.

The information provision step might begin by asking a series of natural questions about the decision, such as:

- What information is required to support the decision?
- How accurate does the information need to be?
- What's the most efficient process for collecting, generating, and supplying the information?
- In what timeframe does the information need to be supplied?

For example, a large national health insurer concluded that its most important decisions were in the areas of claims and such specific activities as claims adjudication, disease management, and claims payment. In order to address these decisions, the firm's managers concluded that it needed to take a bottom-up look at claims information—how the information is gathered and stored around the company. It is constructing a large enterprise warehouse of claims information, and is also developing what it calls “data communities”—a series of focused data marts dealing with specific business problems related to claims.

The challenge of the information provision step—particularly if it is undertaken before decision design—is to keep in mind the specific decisions the information is to inform. It is all too easy to become wrapped up in information management issues and to lose sight of the decisions involved. Organizations need to make sure they have a business intelligence agenda that is being driven by their business objectives.

Step 3: Decision Design

In this step, the key aspects of the context for the decision being made are designed, or at least evolve in a preferred direction. Important considerations in the design process include identification of the roles different individuals will play in the decision, the level of structure for the decision, the ability of human decision-makers to process the relevant information, and the roles of humans vs. computers in the decision process.

In the study of 27 decisions, I found a few organizations in which decision processes were explicitly designed. The energy finance company, where the factors driving executive decisions were explicitly modeled and communicated to decision-makers, is one example of a consciously-designed decision process. The academic medical center's physician order entry system is another. An auto leasing and financing firm is redesigning many automobile financing processes, and is addressing the key decisions made in those processes at the same time.

More frequently, however, the decision context had simply evolved over time with multiple interventions. For example, at a mid-size oil company, the decision involving in which areas to drill for new oil had been the subject of several incremental improvements over time intended to bring greater structure and effectiveness to the decision. The company had invested in a formal “Prospect Evaluation Sheet” that recorded the story and history of how the lead progressed to its current prospect level. The company had also depicted the exploration decision-making process in a visual format, which greatly enhanced the ability of participants to understand their roles, responsibilities, and interactions throughout the process. Still, despite the company's efforts to better structure the decision and a massive amount of seismic and geological information, the decision process remained more iterative and subjective than some managers would have preferred.

In automated decision processes, organizations must explicitly design not only the rules that will be embedded in the automated decision system, but also the performance objectives for the process and the role for human experts in designing and operating the system. In the property and casualty insurance underwriting decision process, the company designed the new process to optimize the cost, time, and quality and consistency of policy underwriting, as well as measures of how long it takes to add or change a rule and modify the underwriting criteria. They followed a rule of thumb for utilizing underwriters to keep the best performers away from routine underwriting. Underwriters should instead do “portfolio management”—looking across all the rules, monitoring performance and looking for new business areas. They also specified the conditions under which human underwriters would become involved in handling exceptions, e.g., those involving high dollar amounts or missing data.

Step 4: Decision Execution

The final step in connecting information and decisions might be to operate and manage the decision process over time, and to ensure that decision-makers use information to make better decisions. This step would almost certainly involve training of users on the available data, on the use of systems to access the data, and perhaps on the factors to consider in decision-making. The regional health insurer, for example, spent considerable resources designing a training program for financially-focused users of the business intelligence system, and then redesigned the training later to address changes in the business and the available data.

Those who are responsible for ensuring effective use of the information in decision processes may also want to enlist influential executives as users. As suggested above, in the urban school district, the frequent and aggressive use of the system by the superintendent led principals and teachers to make more use of it as well. At the Australian university, the school that used the business intelligence system most

effectively had an influential user in the dean of the school.

Organizations will also need to modify and improve their decision processes and systems over time. At the academic medical center, the physicians can override system recommendations that they do not agree with. The institution monitors which treatment decisions are frequently overridden to determine whether they are faulty or unnecessary. The medical center also employs an online discussion system to allow expert physicians to discuss and decide upon new treatments to be added to the order entry system over time (Hongsermeier & Davenport, 2007).

Looking Ahead in Decision Management

Although it is a long-term objective, we are only in the very early stages of improving decision-making and making better use of information in decision processes. As organizations move in this direction, we will undoubtedly learn about new approaches to linking information and decisions, and to improving the broader context for decision-making. We will also probably see new information technologies that attempt to structure and improve decision processes. While we now have many of the technological components for better decisions—including data warehouses, business intelligence tools, workflow systems, decision rule engines, and so forth—these components are not yet well-integrated, and organizations are unsure about how they fit together. Perhaps in the future we will have “decision management” systems that incorporate all these capabilities as well as others. Systems have been used to help select a decision approach in the past, but only in limited contexts (Vroom, 2003).

The primary obstacle to decision improvement efforts is likely to be traditional understandings of management responsibility for decision-making. If organizations view decisions as an individual managerial prerogative—not subject to review or improvement—then they are likely to make little progress in making

them better. Many firms have implicitly treated decision-making in this fashion, and hence they will have difficulty with interventions intended to improve decision-making performance.

Decision-making has always been viewed as one of the most important activities of everyone in an organization, from executives and managers to front and back office employees handling everyday customer interactions and transactions, and it is difficult to overestimate the value of improving it. Decisions have impact on every aspect of organizational performance, in both strategic and tactical domains. Organizations have too much at stake to continue with the poor decision processes of the past. It seems timely for them to address better decision-making as one of the last—and most important—frontiers of business performance improvement.

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