Informing Science: the International Journal of an Emerging Transdiscipline **Volume 14, 2011**

The Information Age Measurement Paradox: Collecting Too Much Data

Nitza Geri
The Open University of Israel
Raanana, Israel

nitzage@openu.ac.il

Yariv Geri
Commercial Aircraft Group IAI
Ben Gurion International Airport, Israel

yarivgeri@gmail.com

Abstract

Information overload is one of the major challenges of management in the information age. Usually, the emphasis in the literature is on incoming information, whereas the creation of information or data is rarely discussed. This paper presents the measurement paradox and demonstrates how managerial decisions, or monitoring conventions, cause collection of tremendous amounts of unnecessary data. The measurement paradox is observed when advanced technologies, such as Enterprise Resource Planning (ERP) systems, which are intended to improve control and provide managers with better information, collect ample data, most of which are unnecessary.

The paper illustrates the measurement paradox by developing a model for estimating the amount of data required for a cost accounting system. It analyzes the amount of data necessary for traditional cost accounting systems, which are usually based on one cost driver, mostly direct labor hours, versus the amount of data used by activity-based costing (ABC) systems, which use multiple cost drivers. It shows that the amount of data depends mainly on the number of measurements, and in order to improve managerial accounting systems and eliminate non-value adding activities, one should reduce the number of measurements.

Keywords: attention economy, activity-based costing/management (ABC/M), cost accounting, managerial accounting, Theory of Constraints (TOC), information management, control.

Introduction

Advanced technologies may be used to help organizations cope with information overload, which is one of the major challenges of the information era (Simon, 1971). The same technologies enable organizations to collect, process, and store vast quantities of data. This paper presents the measurement paradox and demonstrates how managerial decisions, or monitoring conventions, cause collection of tremendous amounts of unnecessary data.

Advanced technologies, such as Radio Frequency Identification (RFID) or web information systems that record the clickstream of people who use a software application or browse the Internet, provide organizations with many opportunities to collect data that may become useful information. Nevertheless, which of these data should be collected?

Material published as part of this publication, either on-line or in print, is copyrighted by the Informing Science Institute. Permission to make digital or paper copy of part or all of these works for personal or classroom use is granted without fee provided that the copies are not made or distributed for profit or commercial advantage AND that copies 1) bear this notice in full and 2) give the full citation on the first page. It is permissible to abstract these works so long as credit is given. To copy in all other cases or to republish or to post on a server or to redistribute to lists requires specific permission and payment of a fee. Contact Publisher@InformingScience.org to request redistribution permission.

Editor: T. Grandon Gill

Should data be collected just because it is available, and perhaps it may have some future use? For example, Google's e-mail service, Gmail, offers its users the ability to keep all their emails by providing them ample storage space. Gmail even reprimands users who delete emails and empty their trash folder, with the message, "Who needs to delete when you have so much storage?!". Conversely, it may be argued that there is no need to save all these emails if there is no foreseeable use for them.

Managers are overwhelmed by ever-growing incoming information and requests for their attention, and their ability to effectively manage their personal, as well as their organization's attention, is a critical success factor, of both the manager and the organization (Davenport & Beck, 2000, 2001). Information overload is a multifaceted challenge, and most often it is discussed from the incoming information angle, such as bounded rationality (Geri & Gefen, 2007; Karr-Wisniewski & Lu, 2010; Simon, 1957, 1971), whereas the creation of information or data is rarely studied.

This study contributes to the informing science transdiscipline (Cohen, 1999, 2009; Gackowski, 2009; Gill & Cohen, 2009) by introducing the concept of the measurement paradox and by developing a model for estimating the amount of data required for a cost accounting system. The model compares the amount of data necessary for traditional accounting systems, which are usually based on one cost driver, generally direct labor hours, versus the amount of data used by activity-based costing (ABC) systems (Cooper & Kaplan, 1988, 1991), which use multiple cost drivers. The model demonstrates the measurement paradox and shows that the amount of data depends mainly on the number of measurements and not on the number of the other parameters of the model, which are the number of cost drivers (i.e., cost allocation bases) and the number of products or services. The model also contradicts a common misconception that due to the use of multiple cost drivers, ABC systems require much more data than traditional cost accounting systems.

Data collection for cost accounting systems was chosen to demonstrate the measurement paradox for three reasons:

- Two main opposing frameworks deal with the appropriate approach for designing an effective managerial accounting system. One of the major differences between these two frameworks is their attitude toward data collection and monitoring. The first framework, ABC (Cooper & Kaplan, 1988, 1991), requires many details, whereas the second framework, the Theory of Constraints (TOC) (Goldratt, 1991; Goldratt & Cox, 1986) focuses on few crucial data. After presenting the model of the data quantity of a cost system, this theoretical context will be used for discussing the model's implications.
- Contrary to financial accounting systems, which must comply with certain laws as well as generally accepted accounting principals, the purpose of cost accounting systems, also called managerial accounting systems, is to support managerial decision-making. The structure of cost accounting systems is at the discretion of the firm's management, and the information from these systems is intended for internal purposes. Sometimes a firm chooses to use its costing system for collecting mandatory data, which is required by other functions, or it serves external reporting needs. In this paper, we deal only with the internal cost accounting function.
- Although ABC has actually failed and it is rarely used in practice (Eden & Ronen, 2002; Geri & Ronen, 2005; Kaplan & Anderson, 2004, 2007), it is still misperceived as superior to traditional cost accounting systems. Modern Enterprise Resource Planning (ERP) systems usually include an ABC module. Since ERP systems enable implementation of complex ABC systems, it is important to understand the implications of choosing to implement such systems,

and of defining their parameters. ERP systems also enable collecting much more data for traditional accounting systems. This paper suggests that such action may be pointless.

The rest of the paper is organized as follows: the next section provides the theoretical context and presents the essence of ABC and TOC. The third section presents a model of the data quantity required for implementing a cost accounting system and analyzes its parameters. The fourth section discusses the implications of the model, and the final section concludes the paper.

Theoretical Context: Two Opposing Approaches

Activity-Based Costing

The activity-based costing approach was suggested by Cooper and Kaplan (1988, 1991) in the mid-1980s as an alternative to traditional cost accounting, which is not suitable for the modern business environment (Johnson & Kaplan, 1987; Kaplan, 1984). ABC is a system intended for managing overhead costs that are the main production costs in the modern era and may account for more than 80% and even 95% of the total costs of an organization. Examples of overhead costs include marketing expenses, engineering, production monitoring and scheduling, materials handling, procurement, transportation, machine maintenance, and so forth. ABC identifies the activities that occurred in the production of products, or in the provision of services, and allocates costs to products according to the specific consumption of resources by each product. Unlike traditional cost accounting systems, which use few allocation bases and most often just one allocation base, which is direct labor hours, ABC employs several allocation bases, usually between 7 to 30 cost-drivers (Cooper & Kaplan, 1991). ABC is supposed to enable organizations to manage all their overhead costs, including selling, marketing, and general expenses, which are not accounted for in traditional cost accounting systems. ABC is based on the assertion that costs cannot be managed, but activities can. ABC is intended to support strategic decisions and its purpose is to focus management attention on resource consumption so it may enable better management of these resources (Cooper, 1990).

The application of ABC requires analyzing all the activities of the organization and building a system that is tailored to the specific characteristics of that organization. The ABC application process includes the following main stages (Cooper & Kaplan, 1991):

1. Identify the main activities of the organization.
2. Sort the activities to the appropriate category: unit of product (e.g., special delivery instructions), batch (e.g., machine set-up), product support (e.g., engineering specifications), plant (e.g., salaries of managers), or customer (e.g., marketing expenses).
3. Aggregate costs in activity pools, which can be allocated by the same allocation base.
4. Define cost drivers.
5. Choose activity measures for allocating the costs.
6. Calculate the allocation rate for each activity.
7. Allocate the costs to products or customers according to their resource consumption.
8. Analyze the meaning of the allocation results.

ABC has been considered to be a promising tool for supporting managerial decisions. However, in spite of the massive promotion by academics and practitioners (Jones & Dugdale, 2002), generally favorable publicity, and the many organizations that have tried to implement ABC, its current use is scarce (Eden & Ronen, 2002; Innes, Mitchell, & Sinclair, 2000), and even those who tried it abandoned ABC after a short pilot period (Armstrong, 2002; Banker, Bardhan, & Chen, 2008; Geri & Ronen, 2005; Johnson, 1992; Malmi, 1997; Searcy & Roberts, 2007).

Many theoretical and practical barriers caused the failure of ABC (Ronen, Lieber, & Geri, 2007), but in the context of this study, the main obstacle is the relatively large amount of data required for its implementation.

The Theory of Constraints

The Theory of Constraints (TOC) was developed by Goldratt in the mid-1980's (Goldratt & Cox, 1986), about the same period that the faults of traditional management accounting became widely recognized (Johnson & Kaplan, 1987; Kaplan, 1984) and ABC was suggested by Cooper and Kaplan (1988). TOC has gained acceptance by researchers and practitioners (Gupta, 2003; Mabin & Balderstone, 2003; Ronen, 2005). There are numerous reports that TOC has provided many organizations with significant performance improvements, such as increased throughput, reduced inventory levels, and shorter lead-time (e.g., Mabin & Balderstone, 2000).

The main concept of TOC is the constraint that prevents the organization from achieving its goal (Goldratt & Cox, 1986). Since the strength of a system is measured by its weakest link, i.e., the constraint, Goldratt (1991) defined five focusing steps for maximizing the performance of a system (see steps 3-7 below) and started the process by identifying the system's constraint. Ronen and Spector (1992) improved the TOC process by adding two preliminary steps (see steps 1-2 below). The seven focusing steps are (Ronen & Pass, 2007):

1. Define the system's goal.
2. Determine global performance measures.
3. Identify the system's constraints.
4. Decide how to exploit the system's constraint.
5. Subordinate the system to the constraint.
6. Elevate the system's constraint.
7. If a constraint has been broken in the previous steps, go back to step 3. Do not let inertia become the system's constraint.

Rosolio, Ronen, and Geri (2008) provide a detailed example that demonstrates TOC's seven focusing steps. They analyze the implementation of a dynamic expert system that was developed according to the theory of constraints approach and implemented at the Ashdod refinery, Israel. The system produced over 3 million USD of extra profits during the first two years of its operation.

First and foremost, the theory of constraints is a general analyzing approach that may be applied in any situation. In addition to TOC applications in various manufacturing settings, such as electronics, automotive, and aerospace (Mabin & Balderstone, 2003), it has been used in health services (Ronen, Pliskin, & Pass, 2006), education (Goldratt & Weiss, 2005), and enterprise software implementation (Ioannou & Papadoyiannis, 2004). TOC thinking processes have been instrumental in analyzing complex settings such as adoption of interorganizational systems (Geri & Ahituv, 2008) and cooperation among competing organizations that share a common interorganizational system (Geri, 2009).

Most of the studies involving TOC focus on its operational and general management aspects and do not relate to ABC, which is mainly covered in managerial accounting literature. One of the few studies that address both ABC and TOC, by Geri and Ronen (2005), describes a large international financial services organization that abandoned the ABC system it had used for seven years and adopted a system based on the principles of TOC. Their analysis, which includes specific examples, examines the strengths and weaknesses of ABC from a global value creation perspective and explains why TOC serves as a better managerial approach.

In the context of gathering and monitoring data, Goldartt (1991), the originator of TOC, has pointed out the "haystack syndrome," which is the phenomenon of having too much data but too little useful information, and suggested that the attention of management should be focused on the organization's constraints. The "haystack syndrome" occurs when organizations collect unnecessary data.

A Model of the Data Quantity of a Cost System

In this section, we develop a model for estimating the amount of data required for a cost accounting system. We then use the model to analyze the amount of data necessary for various accounting systems and compare traditional accounting systems, which are usually based on one cost driver, most commonly direct labor hours, with activity-based costing systems, which use multiple cost drivers. Finally, we show that the amount of data depends mainly on the number of measurements of each cost driver.

The amount of data D required for a cost accounting system depends on three parameters:

- n - The number of cost drivers, i.e., the cost allocation bases, such as direct labor hours, sales volume, or machine hours
- k - The number of products
- P_i - The number of measurements of cost driver i ($i = 1,...,n$)

The number of cost drivers, *n*, is determined by the designers of the cost system. They may choose to use just one allocation base, e.g., direct labor hours, as is the common practice in traditional cost accounting systems, or many allocation bases, as recommended by ABC advocates. As the number of chosen cost drivers increases, the amount of required data also increases. Nevertheless, the magnitude of this increase depends on the number of measurements, P_i, of each cost driver. Again, the designers of the cost system have to decide how many measurements are required. It could be as few as one measurement, which sets a standard, or it can be as many times as a unit of each product is produced, or anything in-between.

The number of products that a firm produces, *k*, is determined by its management. However, in the context of a cost system, it is treated as a given exogenous decision. The term "product" is used here to include all sorts of commodities, products, and services that an organization offers its customers, clients, or the public. The proposed model applies to every type of organization, including governmental units and commercial and service organizations such as retail chains, airlines, banks, or medical centers.

D, the amount of data required for implementing a cost system consists of the following three elements:

1. The amount of data required for setting the cost (i.e., the rate or tariff) for each unit of a cost driver. For each cost driver, we need two pieces of data:
    - The total planned allocated cost, e.g., the total planned yearly salaries of all the employs in a certain department.
    - The number of activities used for planning, e.g., the total planned direct labor hours for the coming year.

    Since there are *n* cost drivers, the amount of required data elements is $2n$.

2. The number of produced units for each one of the products. The amount of data in this case is determined by the number of products: *k*.

3. The total number of measurements of all the cost drivers: $\sum_{i=1}^{n} P_i$

   We assume that $P_i \geq k$ for each *i*, which means that at least one datum of each of the required activities is collected.

Therefore, the total amount of data required for implementing a cost system is:

$$D = 2n + k + \sum_{i=1}^{n} P_i$$

The Amount of Data Required for Various Cost Systems

We now calculate the amount of data, *D*, for the special case where $P_i = k$ for each *i*. That means that there is just one measurement of each one of the activities required for producing each product. This applies to cases where there are established standards for each of the activities, based on past performance or experiments during the design stage, and there are no further measurements during the production phase. Furthermore, this assumption also holds when the number of activities is constant, e.g., the number of components required for manufacturing a certain product.

For $P_i = k$, we get:

$$D = 2n + k + \sum_{i=1}^{n} P_i = 2n + k + nk = 2n + (1+n)k$$

Figure 1 presents the amount of data, *D*, as a function of the number of products, *k*, for set values of cost drivers, *n*. Figure 2 presents *D* as a function of the number of cost drivers, *n*, for set values of products, *k*. Obviously, the amount of required data increases as there are more cost drivers or more products.

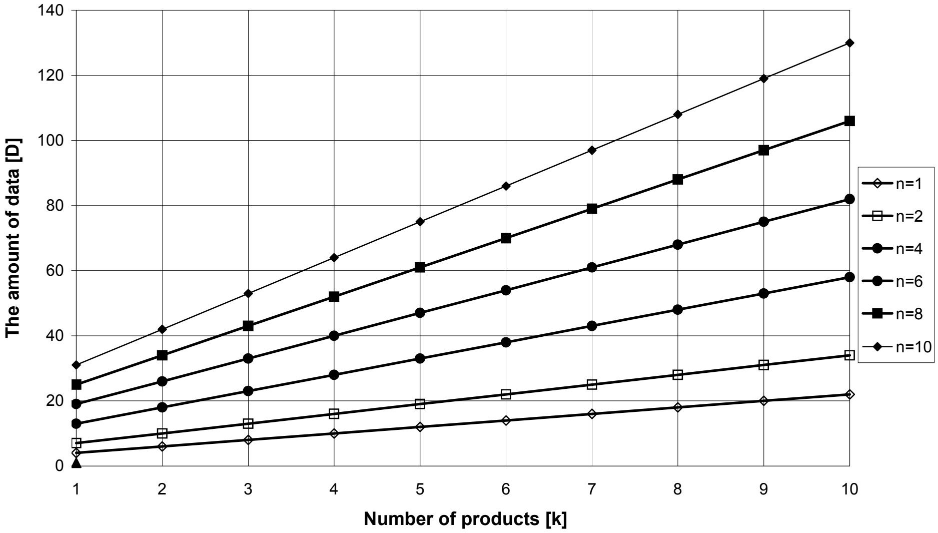


Figure 1: Amount of data [D] as a function of the number of products [k] for set values of cost drivers [n]

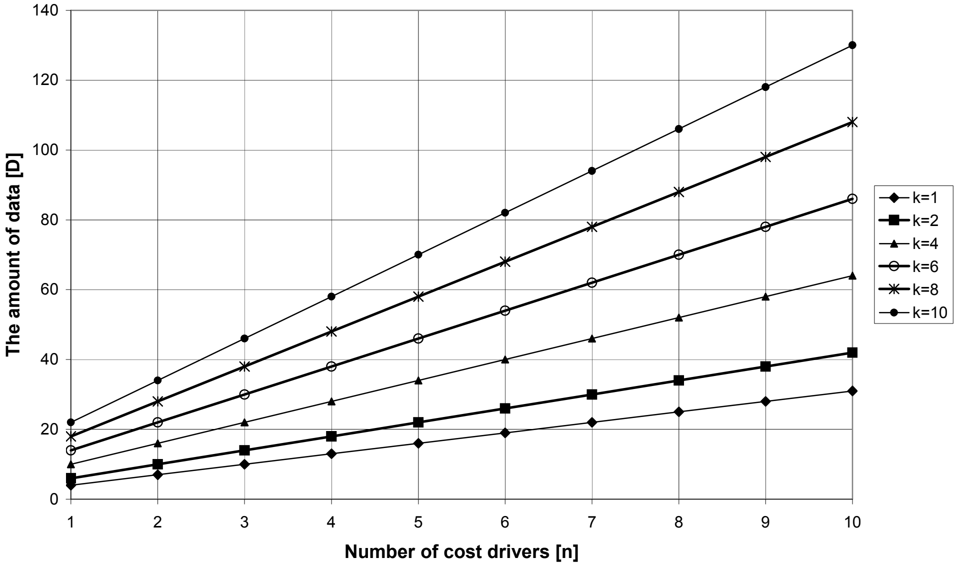


Figure 2: Amount of data [D] as a function of the number of cost drivers [n] for set values of the number of products [k]

The slope of the graphs shown on Figure 1 is: $n+1$.

The slope of the graphs shown on Figure 2 is: $k+2$.

We see that the number of cost drivers, n, has a stronger effect on the amount of data than that of the number of products, k. In order to illustrate this effect, Table 1 presents the amount of data, D, required for a cost system when there are 1 to 10,000 products, k, and there are 1 to 10 cost drivers, n. The calculations are based on the assumption that $P_i=k$, meaning that each activity required for producing a product is measured only once.

Table 1. The amount of data (D) required for implementing a costing system, as a function of the number of products (k) and the number of cost drivers (n), for $P_i=k$*

Cost drivers (n) products (k)	1	2	4	6	8	10
1	4	7	13	19	25	31
10	22	34	58	82	106	130
100	202	304	508	712	916	1,120
1,000	2,002	3,004	5,008	7,012	9,016	11,020
10,000	20,002	30,004	50,008	70,012	90,016	110,020

* When $P_i=k$, each activity that is required for producing a product is measured once.

Usually, when an organization has a traditional cost system there are just a few cost drivers. In most cases, direct labor hours serve as the single cost allocation base. On the other hand, activity-based costing systems typically use several allocation bases. There are usually at least six cost drivers, but sometimes more than 10 cost drivers are used. As shown in Table 1, the amount of data required for an ABC system with six cost drivers is about 3.5 times bigger than the amount of data of a traditional cost system with a single allocation base, when $P_i=k$. We should keep in mind that these are just the basic data, which are used to calculate more data, so the total amount of data is larger. Table 1 demonstrates why ABC systems are perceived as requiring much more data than traditional cost accounting systems. However, as shown in the next sub-section, the number of measurements is the parameter that has the strongest impact on the amount of data, so for $P_i>k$, it is possible that an ABC system that entails few measurements will require less data than a traditional cost system that is based on many measurements.

The Number of Measurements Impact on the Amount of Data

The manner of data collection has a major influence on the quantity of data. One option is to use standard costing, i.e., determine for each product the appropriate parameters (e.g., number of parts, lead-time, process time by each machine for each product, the time needed for performing a certain service) and calculate standard cost according to these parameters. Thereafter, the only required data is the number of units produced of each product. Standard costing is the method that applies to the special case described above, where $P_i = k$ for each *i*. Another option is to accumulate data for each unit and/or each batch of products, e.g., the actual number of parts included in each product, the "exact" lead-time, the actual minutes it took each machine to process a specific unit, or a batch of products, the actual time it took to perform a certain service, such as boarding 189 passengers on a commercial aircraft or approving a bank loan. This option requires much more effort in collecting and processing the data, and the amount of data increases considerably.

When computing the element $\sum_{i=1}^{n} P_i$ in the equation of the quantity of data, *D*, the parameter that has the strongest effect on the quantity of required data is the number of measurements P_i, and not the number of cost drivers, *n*. We demonstrate it in the following example, which compares two cases: in the first one, there is just one cost driver and there are 1,000 measurements; in the second case, there are three cost drivers and there are 100 measurements for each of them.

Case 1:

Assume that $P_1 = P_2 = \ldots = P_i = 1{,}000$ is the number of measurements of cost driver *i*.

$n = 1$ is the number of cost drivers.

$k = 3$ is the number of products.

$$D = 2n + k + \sum_{i=1}^{n} P_i = 2 \cdot 1 + 3 + 1{,}000 = 1{,}005$$

Case 2:

Assume that $P_1 = P_2 = \ldots = P_i = 100$ is the number of measurements of cost driver *i*.

$n = 3$ is the number of cost drivers.

$k = 3$ is the number of products.

$$D = 2n + k + \sum_{i=1}^{n} P_i = 2 \cdot 3 + 3 + \sum_{i=1}^{3} 100 = 309$$

These two simple examples demonstrate that the parameter that has the strongest impact on the amount of data is the number of measurements and not the number of cost drivers.

Discussion

Theoretical Implications, Limitations, and Further Research

Information overload is a multifaceted challenge, and organizations try to deal with it in many ways. For example, techniques such as data mining are used in hope of finding useful information in the vast amounts of data that organizations keep in their databases (Loveman, 2003). Nevertheless, too little attention is given to the aspect of collecting, retaining, and sometimes monitoring unnecessary data, or even having a "haystack syndrome" (Goldratt, 1991).

The model developed in this paper quantifies the amount of data required for implementing a cost accounting system. The three parameters that the model considers are the number of cost drivers, the number of products (which is exogenous to the system), and the number of measurements of each cost driver. The analysis shows that the number of measurements has the strongest influence on the amount of required data. It also demonstrates that a traditional cost system with one cost driver may require much more data than an ABC system with multiple cost drivers. For example, an electronics company used to record 35,000 reports of direct labor each month, and although direct labor accounted for an insignificant portion of its costs, it was used as the single base for allocating overhead costs. As part of a process of ongoing improvement, the reporting was down to less than a hundred per month, and this improvement occurred even before any changes were implemented in the costing system (Cooper & Turney, 1988).

Although the model provides valuable insights, it has some limitations. First, the model does not consider the effort required for gathering different sorts of data. It may be easier to collect hundreds of thousands of similar data values that are measured automatically by an RFID system than to collect a few dozen data values that are manually measured and require human assessment. But most of all, the model does not consider the value of the collected data. Different sorts of data have distinct values that depend on the circumstances. The theoretical context of this paper considers two opposing approaches: ABC (Cooper & Kaplan, 1991) and TOC (Goldratt, 1991). ABC requires analyzing dozens of processes and accounts for each activity that can be traced. Nowadays even the strongest proponents of ABC recognize that it has failed and attribute its failure to difficulties in collecting and analyzing so much data (Kaplan & Anderson, 2004, 2007). On the other hand, TOC that focuses the organizational attention on the constraint has gained practical success and academic recognition (Mabin & Balderstone, 2003). This paper suggests that besides their theoretical soundness, the principles of TOC are more appropriate for guiding managers in deciding about process monitoring and data collection. TOC provides organizations with the means to deal with the vast amounts of data that characterize the modern organizational environment. Nevertheless, more work is needed, and future research may try to integrate the concepts of the Theory of Constraints within the framework of informing science (Cohen, 1999).

Towards a General Model of Data Collection?

It may seem that the next theoretical step should be an effort to develop a general model of data collection that considers the costs of data collection as well as the benefits of the information generated from the data. However, such model is impractical and may be conceptually wrong for the following main reasons:

- The value of information is relative and depends on the user, the timing, and the circumstances (Ahituv, 1980, 1989). Therefore, measuring the expected benefits of using the data is infeasible. Geri, Neumann, Schocken, and Tobin (2008) describe the challenges of information evaluation in the context of providing users with additional information.

- A conventional cost/benefit model ignores the managerial attention required for handling the information, which according to Davenport and Beck (2001) is the constraint of modern organizations. Therefore, organizations should identify their most crucial information and plan their information gathering accordingly, e.g., the expert system described by Rosolio et al. (2008).
- Even if the cost of the gathering apparatus, such as an ERP system, is a fixed sunk cost and the variable costs of collecting the data are negligible, monitoring the data requires organizational attention. Hence, organizations should plan carefully their reported data. Nevertheless, the data that systems gather automatically for various reasons (e.g., compliance with regulations) can be stored and kept for future use, e.g., data mining.

Practical Implications

The main practical implication for managers emanating from this study is the following: *Do not measure it just because you can*. The measurement paradox is caused by managerial decisions to collect unnecessary data or by their inaction in preventing such data from accumulating, regardless of what their advanced information technologies automatically collect.

Another important suggestion for managers is to scan the existing activity measurement and data collection procedures in their organization and eliminate unnecessary activities. Beyond the resources that are wasted on the measurements and the collection, processing and storage of the purposeless data, the organization will also save the time and efforts invested in monitoring the data, explaining deviations, and handling exceptions.

Managers responsible for managerial accounting systems may use the insights from the suggested model and evaluate their choice of cost drivers and measurement policy.

Conclusions

This paper presented the measurement paradox and showed how organizations exacerbate their own information overload challenge by using the powers of advanced technologies to collect loads of unnecessary data. The research contributed to the informing science transdiscipline (Cohen, 1999, 2009) by analyzing the collection of data by organizations. This perspective distinguishes it from most of the studies of information overload that focus on incoming data (e.g., Davenport & Beck, 2001).

In order to demonstrate the measurement paradox and show how managerial decisions influence the amount of collected data, the paper developed a model for estimating the amount of data required for a cost accounting system. The analysis compared traditional costing systems with ABC systems that are based on multiple cost drivers. It showed that, unlike the common misconception, ABC does not necessarily require more data than traditional costing systems, because the amount of data depends mainly on the number of measurements and not on the number of cost drivers. Therefore, in order to improve managerial accounting systems and eliminate non-value adding activities, one should reduce the amount of measurements.

The implications of the model were discussed through the lenses of two opposing frameworks, which differ in many aspects as well as in their attitude toward data collection and monitoring. While ABC (Cooper & Kaplan, 1991) requires many details, the Theory of Constraints (Goldratt, 1991) focuses on few crucial data. The paper suggests that besides their theoretical soundness, the principles of TOC are more appropriate for guiding managers in deciding about process monitoring and data collection.

References

Ahituv, N. (1980). A systematic approach toward assessing the value of an information system. *MIS Quarterly, 4*(4), 61-75.

Ahituv, N. (1989). Assessing the value of information: Problems and approaches. *Proceedings of the 10th Annual International Conference on Information Systems (ICIS)*, Boston, MA, 315-325.

Armstrong, P. (2002). The costs of Activity-Based Management. *Accounting, Organizations and Society, 27*(1-2), 99-120.

Banker, R. D., Bardhan, I. R., & Chen, T-Y. (2008). The role of manufacturing practices in mediating the impact of activity-based costing on plant performance. *Organizations and Society, 33*(1), 1-19.

Cohen, E. (1999). Reconceptualizing information systems as a field of the transdiscipline informing science: From ugly duckling to swan. *Journal of Computing and Information Technology, 7*(3), 213-219.

Cohen, E. (2009). A philosophy of informing science. *Informing Science: the International Journal of an Emerging Transdiscipline, 12*, 1-15. Retrieved from http://inform.nu/Articles/Vol12/ISJv12p001-015Cohen399.pdf

Cooper, R. (1990). Explicating the logic of ABC. *Management Accounting, CIMA, UK*, (November), 58–60.

Cooper. R., & Kaplan, R. S. (1988). Measure costs right: Make the right decisions. *Harvard Business Review, 66*(5), 96–103.

Cooper, R., & Kaplan, R. S. (1991). *The design of cost management systems*. Englewood Cliffs, NJ: Prentice Hall.

Cooper. R., & Turney, B. B. (1988). Tektronix: Portable Instrument Division. *Harvard Business School,* cases 188-142, 188-143.

Davenport, T. H., & Beck, J. C. (2000). Getting the attention you need. *Harvard Business Review, 78*(5), 118-126.

Davenport, T. H., & Beck, J. C. (2001). *The attention economy: Understanding the new currency of business*. Boston, MA: Harvard Business School Press.

Eden, Y., & Ronen, B. (2002). Activity Based Costing (ABC) and Activity Based Management (ABM) – are they the same thing in a different guise? *Financial Management Accounting Committee (FMAC) Articles of Merit*, Issued by The International Federation of Accountants, pp. 47–58.

Gackowski, Z. J. (2009). *Informing for operations: Framework, model, and the first principles*. Santa Rosa, CA: Informing Sciences Press.

Geri, N. (2009). Overcoming the challenge of cooperating with competitors: Critical success factors of interorganizational systems implementation. *Informing Science Journal: the International Journal of an Emerging Transdiscipline, 12*, 123-146. Retrieved from http://inform.nu/Articles/Vol12/ISJv12p123-146Geri532.pdf

Geri, N., & Ahituv, N. (2008). A Theory of Constraints approach to interorganizational systems implementation. *Information Systems and e-Business Management, 6*(4), 341-360.

Geri, N., & Gefen, D. (2007). Is there a value paradox of e-learning in MBA programs?. *Issues in Informing Science and Information Technology, 4*(1), 163-174. Retrieved from http://proceedings.informingscience.org/InSITE2007/IISITv4p163-174Geri322.pdf

Geri, N., Neumann, S., Schocken, R., & Tobin, Y. (2008). An attention economy perspective on the effectiveness of incomplete information. *Informing Science Journal: the International Journal of an Emerging Transdiscipline*, *11*, 1-15. Retrieved from http://inform.nu/Articles/Vol11/ISJv11p001-015Geri509.pdf

Geri, N., & Ronen, B. (2005). Relevance lost: The rise and fall of activity-based costing. *Human Systems Management, 24*(2), 133-144. Retrieved from http://boazronen.org/PDF/Relevance%20Lost%20-%20The%20Rise%20and%20Fall%20of%20Activity%20Based%20Costing.pdf

Gill, T. G., & Cohen, E. (Eds.). (2009). *Foundations of informing science, 1999-2008*. Santa Rosa, CA: Informing Sciences Press.

Goldratt, E. M. (1991). *The haystack syndrome*. Great Barrington, MA: North River Press.

Goldratt, E. M., & Cox, J. (1986). *The goal: A process of ongoing improvement*. Croton-on-Hudson, NY: North River Press.

Goldratt, R., & Weiss, N. (2005). Significant enhancement of academic achievement through application of the Theory of Constraints (TOC). *Human Systems Management, 24*(1), 13-19.

Gupta, M. (2003). Constraints management: Recent advances and practices. *International Journal of Production Research, 41*(4), 647-659.

Innes, J., Mitchell, F., & Sinclair, D. (2000). Activity-Based Costing in the UK's largest companies: A comparison of 1994 and 1999 survey results. *Management Accounting Research, 11*(3), 349–362.

Ioannou, G., & Papadoyiannis, C. (2004). Theory of Constraints-based methodology for effective ERP implementations. *International Journal of Production Research, 42*(23), 4927-4954.

Johnson, H. T. (1992). It's time to stop overselling activity-based concepts. *Management Accounting, 74*(3), 26-35.

Johnson, H. T., & Kaplan, R. S. (1987). *Relevance lost: The rise and fall of management accounting*. Boston, MA: Harvard Business School Press.

Jones, T. C., & Dugdale, D. (2002). The ABC bandwagon and the juggernaut of modernity. *Accounting, Organizations and Society, 27*(1-2), 121-163.

Kaplan, R. S. (1984). Yesterday's accounting undermines production. *Harvard Business Review, 62*(4), 95–101.

Kaplan, R. S., & Anderson, S. R. (2004). Time-Driven Activity-Based Costing. *Harvard Business Review, 82* (11), 131-138.

Kaplan, R. S., & Anderson, S. R. (2007). *Time-Driven Activity-Based Costing: A simpler and more powerful path to higher profits*. Boston, MA: Harvard Business School Press.

Karr-Wisniewski, P., & Lu, Y. (2010). When more is too much: Operationalizing technology overload and exploring its impact on knowledge worker productivity. *Computers in Human Behavior, 26*(5), 1061–1072. DOI:10.1016/j.chb.2010.03.008

Loveman, G. (2003). Diamonds in the data mine. *Harvard Business Review, 81*(5), 109-113.

Mabin, V. J., & Balderstone, S. J. (2000). *The world of the Theory of Constraints: A review of the international literature*. Boca Raton, FL: St. Lucie Press.

Mabin, V. J., & Balderstone, S. J. (2003). The performance of the Theory of Constraints methodology: Analysis and discussion of successful TOC applications. *International Journal of Operations and Production Management, 23*(5/6), 568–595.

Malmi, T. (1997). Towards explaining Activity-Based Costing failure: Accounting and control in a decentralized organization. *Management Accounting Research, 8*(4), 459-480.

Ronen, B. (Ed.) (2005*). The Theory of Constraints: Practice and research*. Amsterdam: IOS Press.

Ronen, B., Lieber, Z., & Geri, N. (2007). Value focused management (VFM): Capitalizing on the potential of managerial value drivers. In Y. Shi, D. L. Olson, & A. Stam (Eds.), *Advances in multiple criteria decision making and human systems management: Knowledge and wisdom* (pp. 149-175). Amsterdam, The Netherlands: IOS Press. Retrieved from http://www.boazronen.org/PDF/VFM%20-%20Capitalizing%20on%20the%20Potential%20of%20Managerial.pdf

Ronen, B., & Pass, S. (2007). *Focused operations: Achieving more with existing resources*. Hoboken, NJ: John Wiley and Sons.

Ronen, B., Pliskin, J. S., & Pass, S. (2006). *Focused operations management for health services organizations*. San Francisco, CA: Jossey-Bass.

Ronen B, & Spector, Y. (1992). Managing system constraints: A cost/utilization approach. *International Journal of Production Research, 30*(9), 2045-2061.

Rosolio, I., Ronen, B., & Geri, N. (2008). Value enhancement in a dynamic environment - A constraint management expert system for the oil refinery industry. *International Journal of Production Research, 46*(16), 4349-4367. Retrieved from http://recanati.tau.ac.il/Eng/_Uploads/dbsAttachedFiles/RP_59-2008_Ronen.pdf

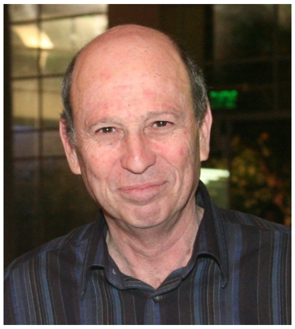
Searcy, D. L., & Roberts, D. (2007). Will your ABC system have what it takes?.*Management Accounting Quarterly, 8*(3), 23-26.

Simon, H. A. (1957). *Models of man: Social and rational*. New York: John Wiley and Sons, Inc.

Simon, H. A. (1971). Designing organizations for an information-rich world. In M. Greenberger (Ed.), *Computers, communications and the public interest* (pp. 40-41). Baltimore, MD: Johns Hopkins Press.

Biographies

Nitza Geri is Head of the Department of Management and Economics, the Open University of Israel and a member of the Research Center for Innovation in Learning Technologies. She holds a B.A. in Accounting and Economics, an M.Sc. in Management Sciences, and a Ph.D. in Technology and Information Systems Management from Tel-Aviv University. Nitza is a CPA (Israel) and prior to her academic career she had over 12 years of business experience. Her research interests and publications focus on various aspects of the value of information, and information systems adoption and implementation, including strategic information systems, e-business, value creation and the Theory of Constraints, managerial aspects of e-learning systems adoption and use. Personal site: http://www.openu.ac.il/Personal_sites/nitza-geri.html



Yariv Geri is an engineer at Commercial Aircraft Group IAI Ltd. Yariv holds a B.Sc. and an M.Sc. in Mechanical Engineering, as well as an M.Sc. in Management Sciences from Tel-Aviv University. His research interests include operations management, especially value creation and the Theory of Constraints, and the value of information in decision-making processes.