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Performance Analysis in Information Technology: Identifying Product and Service Contributions

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Introduction
To compete in the current marketplace, organizations must improve the performance of their operations. Productivity measures have provided the basis for determining performance (Chew 1988). Information technology (IT) is undergoing increasingly critical examination regarding the value of its contribution to the organization’s mission (Brynjolfsson and Hitt 1996, Brynjolfsson 1993, Drucker 1991, Panko 1991). Although a clear increase in productivity from the use of IT has not been found, organizations still turn to IT to improve their performance. This “productivity paradox” has long puzzled both researchers and practitioners. Because organizations continue to implement new IT, we must conclude either that firms are implementing IT without gaining benefits or that some of the contributions IT makes have not been adequately measured. This leads to our research question:

What are the additional factors of information technology that impact the performance of organizations and how do they relate to traditional analysis methodologies of performance measurement?

The Nature of Productivity Analysis
Productivity analysis first originated in themes developed by Frederick Taylor (published in his 1911 foundation work, Scientific Management) on methodologies to improve the productivity of manufacturing processes. This research was based on the Process-Product Model (P-PM). The essential premise of this model is that inputs are physically changed by a process into durable outputs (Sink 1985, p. 3). Early research focused on labor and physically measurable products. Soon this was extended to investigate clerical productivity with transactions as products. The P-PM provided the cost justification concepts for early computerization efforts as capital (computer systems) was substituted for labor (clerical processing). White-collar productivity was the next subject of performance scrutiny (Carkhuff 1983, p. 25).

The general adoption of information-as-product concept can be seen as the continued application of the P-PM to information technology systems. However, the P-PM paradigm makes two important stipulations. First, organizations control the inputs to the process and can ensure their consistency. Second, the production process converts inputs into physically measurable outputs. Neither of these stipulations holds completely for IT. The premise that the outputs of information technology processes are physically measurable information products is a derivative of the second stipulation. Physically immeasurable outcomes, however, are the more likely constituents of many major outputs from IT systems (Brynjolfsson 1993, Fisher 1995, Parker and Benson, 1989, Pitt et al. 1995).

The Concept of Productivity
Productivity, a process measure, refers to the measurable results that exist after changing a particular defined set of inputs into an expected set of outputs (Sink 1985, p. 3). Operationally, productivity is defined as outputs divided by inputs \( P = O/I \). This ratio provides a measure of the relationship between the use of resources and output – an instant measure of productivity (Chew 1988, Sink 1985). To obtain a meaningful interpretation of a productivity measure, it must be compared to a similar criterion measure based on an earlier measurement or an established value \( P_b \). The numeric result of comparing two productivity measures is a productivity index. This relationship is usually expressed as a ratio of the current measure to the base measure \( P/P_b \). The measure of productivity improvement, however, has no meaning if the inputs and/or the outputs are not essentially the same at both measurement instances. In most applications of information technology, many of the quantitative and most of the qualitative factors associated with a given set of inputs differ each time the process begins. As each application or problem cycle begins, the user receives a fresh group of requirements, similar to but different from the previous set of requirements. Without such equivalence, we cannot assure the validity of any productivity measure.
Earlier studies were unable to empirically confirm the contribution of information technology to an organization’s productivity (Brynjolfsson 1993, Panko 1991). More recent analysis has provided some general confirmation of the beneficial contribution of IT but does not identify sources of value (Brynjolfsson and Hitt 1996). The ineffectiveness of current IT productivity measurement mandates the development of alternative methodologies to guide the development and evaluation of information technology processes. An emerging area of IT research is examining the use of service quality as a measure of IT performance (Kettinger and Lee 1997, Pitt et al. 1997, Pitt et al. 1995). The link between this research and productivity has yet to be established.

We suggest that the P-PM approach excludes consideration of the service dimension when evaluating IT’s contribution to organizational performance. In IT, we often lack consistency of inputs and outputs. The typical environment of an IT system is significantly more dynamic and fluid than one that satisfies the requirements of the P-PM. An expanded collection of IT outcomes fall in two general categories: information products and information services. Information products include transactions, documents, reports, analysis, and messages. Information services include decision support, reference, operations control, and communication (Pitt et al. 1995).

Information economics research indicates that IT performance analysis should be extended to include the value of its contribution (Parker et al. 1988, Parker and Benson 1987). The value dimension is also missing from the P-PM framework. Only a portion of the value produced by an IT system can be attributed directly to its products. The rest of the value achieved by IT systems is accomplished indirectly through the effective use of its service and product outcomes by users. Although cost justification is still frequently used to support changes and improvements to IT systems, most of the benefits are achieved through value gains from services and products that support operational activities (Brinberg 1989, Fisher 1995, Parker et al. 1990).

A more robust model than the P-PM, therefore, is required to conceptually represent the complexities of a contemporary IT environment. We propose a Process-Service Model, P-SM, to provide the conceptual framework necessary to effectively pursue performance evaluation of IT systems.

**A New Evaluative Framework: The Process-Service Model**

Research on the services sector of our economy provides an alternate view of value creation. One of the more important of these is the service sector process model (Kong and Mayo 1993, Kolter 1991, Parasuraman, Aethaml & Berry 1985). The inputs to a service process are generally variable in quality, quantity and arrival rate. These factors are usually independent of the process operators. The interaction of the inputs with the process is often voluntary and usually non-causal. The process outcomes are highly dependent on the process inputs and consequently exhibit wide variations. Many of the IT system outcomes and processes identified earlier share this nature.

The inputs to the service model are consumers. The model explicitly recognizes that the consumer is independent from, and essential to, the success of the service organization. The model further postulates that the success of the service process is dependent upon the success of the interaction of the consumer with the service process in achieving the desired outcomes (Schlesinger and Heskett 1991). We suggest a conceptual adaptation of this model for IT systems that embraces the PP-M and includes the value dimension. This new model, called the Process-Service Model (P-SM), is presented in Figure 1. The incorporation of the existing P-PM is essential to the theoretical and conceptual vitality of the proposed model for two reasons: 1) many of the service processes are dependent upon the indirect results and data stores of the product processes, and 2) the value gained from information products is substantial.

Applying this model to IT, the user is placed in the role of the consumer and the IT system includes the service process. This proposed Process Service Model (P-SM) may provide a more useful paradigm for researchers and practitioners in analyzing and improving the performance of information technology processes. The resulting model illuminates the interactive and voluntary nature of the user’s relationship with the information technology process. The actual success of this interaction can only be determined by examining the outcomes that result from the user's activities.

This model also significantly refocuses the attention of IT researchers on the essential issue of value as the most meaningful basis for assessing the performance of IT systems. It also recognizes that this value is largely imbedded in the contribution of IT to the achievement of user and organizational objectives.

**Conclusion**

A portion of the impact of information technology is direct. This direct impact is measured by looking at the value of IT’s product-producing activities. Most IT research has generally pursued this approach. However, much of the impact of IT is indirect in nature. This contribution may be better identified if we consider IT as a service producing activity as well as one that produces products. To effectively determine IT’s contribution to the enterprise, it is necessary to consider the value it adds to the outcomes sought by the organization.

This research reviewed current concepts of productivity in a product based environment and in a service based environment. We then applied these models to information technology to develop a new model of the value generated by IT. Including this service-based component of IT represents a new way of examining the contribution of IT to the functioning of organizations. This model may provide the framework essential to develop meaningful measures of IT performance that can resolve the productivity paradox.
References

Figure 1. Process—Service Model