Measuring the Productivity of Office Organizations

NORMAN P. ARCHER

FACULTY OF BUSINESS

McMASTER UNIVERSITY

HAMILTON, ONTARIO

Research and Working Paper Series No. 241
August, 1985

MEASURING THE PRODUCTIVITY OF OFFICE ORGANIZATIONS

Norman P. Archer

Faculty of Business

McMaster University

Hamilton, Ontario L8S 4M4

Canada

Telephone (416) 525 9140 Ext. 3944

August, 1985

MEASURING THE PRODUCTIVITY OF OFFICE ORGANIZATIONS

ABSTRACT

Office productivity is an important issue, but attempts to improve office productivity lack credibility until it can be defined and measured. This paper discusses a multi-attribute value measurement approach to the evaluation of productivity in the office organization. Since the cost of operating an office organization is not difficult to determine, the focus is on the measurement of the value of the office product, which is information output. A proposed procedure is described which may be used not only to measure the value of office output and hence office productivity, but to determine which information output attributes should be adjusted in order to improve productivity.

KEYWORDS

Office productivity, multiattribute measurement, information value.

MEASURING THE PRODUCTIVITY OF OFFICE ORGANIZATIONS

INTRODUCTION

Productivity in the office, or white collar productivity, is becoming a subject of wide interest. The primary motivations for this interest are that office productivity improvement has for many years lagged behind improvements in manufacturing and other sectors, while at the same time the percentage of the work force engaged in office-type work has risen steadily until it now is in the range of 50% in a number of countries in the industrialized world. The implications are that the slow improvement in office productivity has had a dampening impact on overall productivity improvement, with a resulting negative impact on economic growth and standard of living.

In the same way that automated manufacturing is having an impact on productivity on the factory floor, the various evolutionary thrusts of computer usage in the office (information sytems, decision support systems, expert systems, computer aided design, office automation, etc.) appear to be having a substantial impact on productivity in the office environment. However, it has never been easy to define, let alone measure office productivity. Approaches applied to office productivity measurement and improvement generally rely on techniques developed for use in the factory (Lehrer, 1983). Such approaches ignore the reality that information is a product which has much different characteristics than tangible products turned out on the assembly line.

The introduction of the new automated tools in the office makes it even more difficult yet imperative to measure office productivity since the impact of these tools may also result in radical changes in the structure (Giuliano, 1982), tasks, and management of the office in such ways as:

a) Office organizations and operations change in many ways (Olson and Lucas, 1982) as a result of the introduction of automation (for example, distributed computing allows a more decentralized office organization),

b) Task structures change, and tasks may become either more or less menial and/or structured with resulting changes to perceived status and job satisfaction,

c) Managers have an insatiable appetite for more information upon which to base decisions, and the impact of gathering this new information may be difficult to reconcile with the existing organizational structure,

d) Unstructured tasks are increasingly being aided by the introduction of automation (e.g. decision support systems) and traditional productivity measures in an unstructured environment are difficult to quantify,

e) The contribution of management to organizational productivity is difficult if not impossible to measure, and can be considered only in the context of overall organizational performance.

It is apparent that the impact of automation is invariably felt beyond the bounds of any particular individual in an organization, so in order to measure this impact it becomes critical to measure organizational productivity. Here, the organization can be defined as any subset of the corporation which can be bounded in a natural manner, such that interactions across that boundary can be well-defined. Thus, the organization being considered could include the company itself. Or it could include any sub-unit within the company, along with its management, which carries out a specific set of distinct functions as a service to the rest of the company or to the outside world.

There exist numerous definitions of productivity. For the purpose of this paper, organizational productivity will be defined for the output of that organization as

Productivity = Value Added / Cost Of Adding That Value.

The Cost factor in this equation is normally not difficult to quantify. It includes all direct or indirect costs of operating the organization, such as labor, management, capital, utilities, space rental, supplies, etc. but it excludes the cost of any information inflows to the organization.

The Value Added to information processed by the organization includes those processes such as transcription which change the form of input information, as well as the creative processes which require little direct input information.

Most studies to date on assessing information or information systems have focussed strictly on the concept of value. However, it is clear that in a real sense the cost of supplying that information must also be considered, since cost is a prime consideration in implementing any information system and it has a direct effect on the productivity measure. If we use a productivity measure as a suitable means of comparison, then we can satisfy both the need to consider the real value of the information product as well as the cost of producing that product. With some care, it should be possible not only to measure the productivity of the organization producing the product, but to place a bound (Mason, 1979) on that productivity for a given organizational system.

Strassman (1985, Chapters 6 and 7) differentiates between efficiency and effectiveness in office productivity measures. A close examination of these two measures indicates that efficiency tends to be the primary concern of the producer and effectiveness tends to be the primary concern of the consumer. If we take the more general point of view of the company which contains the organization which is being measured, it is no longer necessary to differentiate between producer and consumer. Whether or not productivity change is achieved by improvements in efficiency (e.g. through cost reductions or by increases in output quantity of the same product) or by improvements in effectiveness (e.g. improvement in quality), both can contribute to productivity improvement. Hence, the overriding concern in office productivity measurement should be in measuring the value of the output product.

The Value Added factor is difficult to quantify for information products. However, a number of researchers have developed a variety of techniques to measure information value. Almost all of these techniques are based on the perceptions of the company's internal users of the information. These users are "customers" of the organization, but in contrast to external users there is no market price by which a value for the information can be established. In essence, the internal user's perceptions of information value may be used to assign a "market value" to the producing organization's output, in the absence of a real market structure.

King and Epstein (1983) include a useful bibliography on approaches to assessing information system value. Most of the published studies mentioned in their paper focus on some measure of the value of information based on a set of attributes for a particular product rather than a set of products which may be supplied by an organization.

Gallagher (1974) used a semantic differential value measure to correlate with estimated dollar value of a particular report. Zmud (1978) also used semantic differential to investigate the dimensionality of information (i.e. the attributes of information). In each case, the investigation was restricted to one type of information report. King and Epstein (1983) used multiattribute techniques to measure the value of information, based on a variety of information attributes gathered from other studies. Their study assumed a linear weighting for the contributions of each attribute to the total value of the information system. This is equivalent to the assumption of an additive multiattribute value model, but they did not show that this model was appropriate in the circumstance studied.

THE MULTIATTRIBUTE MODEL

If we can measure the value of the information output of an information supplying organization, either by market value or by user/customer perceptions, then it will be possible to combine this with cost information to produce a productivity measure for the organization. The information outputs of most such organizations will include more than one type of information in some form such as text, tabular, graphical, or verbal.

Suppose that there are K classes of information outputs or "products", and that V_k represents the value of the k^{th} information product. Generally, V_k will be a function of several attributes. If all information attributes X are indexed according to some set S, then the subset S_k will represent the I(k) indexes of the attributes appropriate to information product k. If the i^{th} attribute of set S_k is denoted by X_{ki}, with measure x_{ki}, then the value of the k^{th} information product is

$$V_k(x_{k1}, x_{k2}, \ldots\ldots, x_{kI(k)})$$

If the value attributes for a particular information product are mutually preferentially independent (Keeney and Raiffa, 1976, Chapter 3), then an additive model is appropriate such that

$$V_k = a_1 x_{k1} + a_2 x_{k2} + \ldots\ldots + a_K x_{kI(k)}.$$

If the assumption of mutually preferentially independent attributes is not appropriate, then more complex value models may be required. We will not pursue this topic further, but will focus on the measurement and analysis of additive models. The more complex models may also be used, but it is more efficient to concentrate on the analysis and design of approaches which are more likely to result in additive models. Using elicitation techniques common to Multiple Attribute Value Theory (MAVT) (Keeney and Raiffa, 1976), it is possible to measure not only the current value of a particular information product as perceived by its consumers, but to measure the value function for that product over ranges of measures taken on by any of its attributes. This is important when the suppliers of the product are interested in improving their productivity, since the value functions allow the estimation of product value changes for any attribute adjustments which may be made as a result of the study.

Examples of value function measurements in a non-information system environment are given by Keeney and Raiffa (1976, Chapter 7). The actual instruments which may be used for such measurements must be carefully designed to avoid confusion in interpreting the meaning of the questions. Torrance, Boyle and Horwood (1982) describe a suitable instrument for eliciting information from subjects in a health status survey. This uses a combination of structured interviews with a visual value scale and movable arrows, each with a written measure of the attribute under study. We have used a similar technique for information attribute measurement, with good success.

To ensure that the attributes of each information product are mutually preferentially independent is very difficult. However, there are techniques which can be used both to reduce the attribute dimensionality of a value function and to reduce or eliminate the correlation among the attributes. While lack of correlation does not imply mutual preferential independence, it does improve the applicability of the additive model. Attributes which are simply selected from a list are not necessarily uncorrelated and it may be essential to carry out a preliminary study to select attributes which have a minimum of mutual correlation but which also adequately describe the information product. In a study of appropriate report formats, Zmud (1978) used a semantic differential approach, along with factor analysis, to derive suitable attributes for user attitudes to report format. This is a concept which is widely used in market research studies (Urban and Hauser, 1980, Chapter 8) to measure customer preferences.

Although the semantic differential approach combined with factor analysis is useful in minimizing correlation among the final attributes selected, it is not always possible to describe these attributes to subjects in such a manner as to preserve this characteristic. However, if the approach used in applying the MAVT model in data collection does not require the assumption of an additive model , then it is possible to test for the appropriateness of the additive model in the final results (Keeney and Raiffa, Chapter 7).

In the final analysis, the productivity of the target organization is to be determined. If a suitable transformation t_k is known for the K information products which will transform relative value V_k , $1 <= k <= K$, into absolute value, then this can be applied giving total added value

$$T = \sum_{k=1}^{k=K} [t_k(V_k) - u_k]$$

Here, u_k represents the value of information inputs purchased by the organization for use in producing product V_k. Total organizational productivity P can then be calculated as

$$P = T / C$$

where C represents the cost of operating the information supplying organization.

A PROPOSED PROCEDURE FOR THE PRODUCTIVITY ANALYSIS OF AN ORGANIZATION

An approach which may be used in organizational productivity analysis would proceed as follows:

1) The customers of the target organization are identified. For an office organization, these are typically internal to the firm. If the customers are external, then the value of services sold to these customers is simply the revenue received by the organization.

2) Assuming the more usual situation that the customers of the target organization are internal to the firm, the (information) "products" or "services" supplied to the "customer" organizations should be classified according to the customer needs satisfied. Since the amount of data collection to measure product value is proportional to the number of product classifications, this number should be kept as small as possible by identifying and studying those products which consume the most resources. These products are most likely to be likely targets for the greatest efforts at productivity improvement.

If it is possible to isolate the contributions made by the target organization to a particular product class, then that product class may be studied separately from other classes, possibly as a pilot project.

3) A list of the attributes to be measured for each product class is now prepared. If the list of attributes for each

product class is known to be mutually uncorrelated, then that list may be used directly in determining the value functions and product value. In this case it is possible to skip to step 5.

In determining suitable value-related attributes, the following attributes were reported by King and Epstein (1983) for evaluating satisfaction or information value in a particular decision-making context: reporting cycle, sufficiency, understandability, freedom from bias, reporting delay, reliability, decision relevance, cost efficiency, comparability and quantitativeness. Other attributes which could be added to this list include security and accessibility. It is important to note that no study has shown that the above attributes are either mutually uncorrelated or independent, especially in the context of any particular user environment.

4) For each product class for which the attribute list is not known to be uncorrelated, a study should be carried out to establish a suitable set of uncorrelated attributes. This may involve the semantic differential approach (Urban and Hauser, 1980) in which a binary set of adjectives are developed to describe each product class, and then customer reactions to each adjective are measured on a Likert scale in the form of a structured questionnaire. Another commonly used technique involves questionnaire design where standard questions are responded to on a Likert scale.

The results from the questionnaires are then factor analyzed (Green, 1978, Chapter 8) to reduce the number of dimensions, with appropriate rotations to allow only either large or small loadings of the original variables to each of the factors. A reduced factor set may then be used, with appropriate descriptions, to provide the mutually uncorrelated attributes for the final MAVT information value study.

5) Given a set of mutually uncorrelated information attributes for each of the product classes, questionnaires can now be designed which will allow the value functions for each attribute-product class pair to be plotted out, through structured interviews with a suitable sample or with the population of customers. Each subject is also queried for perceptions of the value of the product at each "corner point" of the joint attribute space and for value perceptions of some of the interior points. The former results will allow testing of the additive model assumption, and the latter will allow testing of the value model ultimately adopted for that product. Since the subjects are queried concerning combinations of all the attributes for each product class, it is very difficult to measure value contributions for more than a maximum of about four attributes on any one product class, so the attribute set should be kept as small as possible. Hierarchical approaches discussed by Keeney and Raiffa (1976, Chapter 6) may also be used to reduce the dimensionality of the problem if certain attributes are based on combinations of other attributes.

To estimate the contribution of attributes which have a minimal value impact and which must be left out to keep the set small enough to study in this manner, it is possible to use the additive model assumption and have subjects estimate the values of all the proposed attribute set on a single scale. This can be used later if the additive model assumption should turn out to be appropriate. Since subjects differ in their perceptions of attribute importance, the additive model data can be used in any case as an extension to the model actually identified, to ensure that all the value contributions are accounted for in some way, no matter how small. In addition to the above measures, the subjects should also be asked to estimate the current attribute measures and the joint value to them of each product class: as it currently exists, and as they would prefer it to be. These latter results will give the current value of the information products and will also indicate the direction of change desired, if any, on each of the attributes.

6) During the data collection phase in section 5) above, data are also gathered on "willingness to pay" for each product class, in terms of some measure which is common among all the product classes. For example, the user could be asked how much time he or she would be willing to budget to do the task currently done by the supplying organization. This estimate may then be used to convert the measured relative values to absolute values on a common scale for all information products evaluated.

7) The final phase is to aggregate the statistical data to determine if the additive model is correct; and if it is not, to derive an appropriate multiplicative model and test it using the interior data also gathered during the collection phase. The productivity of the organization can then be analyzed, using the cost and value information collected. The "willingness to pay" information can now be used to determine the absolute value of the product class, aggregated over all users, and to determine

the absolute value of all outputs from the target supplyier organization. Taken together with the costs of supplying the information products, the overall productivity of the supplying organization can now be calculated.

Using the aggregated value functions, it should now be possible to determine in which direction to change the product attributes in order to improve the productivity of the target organization. When and if these changes are made, further sampling is necessary only to measure the current perceived value of the product class, since the value functions are now known. These data will assist in checking that the appropriate productivity improvements did in fact occur.

REFERENCES

1. Gallagher, C.A., "Perceptions Of The Value Of A Management Information System", Academy Of Management Journal, 17, 1974, pp. 46-55.
2. Giuliano, Vincent E., "The Mechanization Of Office Work", Scientific American, (September 1982), pp. 125-134.
3. Green, Paul E., Analyzing Multivariate Data, Dryden Press, Hinsdale, Illinois, 1978.
4. Keeney, Ralph L. and Raiffa, Howard, Decisions With Multiple Objectives: Preferences and Value Tradeoffs, Wiley, New York, N.Y., 1976.

5. King, William R. and Epstein, Barry J., "Assessing Information System Value: An Experimental Study", _Decision Sciences, 14_, 1983, pp. 34-45.

6. Lehrer, Robert N., _White Collar Productivity_, McGraw-Hill, New York, N.Y., 1983.

7. Mason, Richard O., "A General Systems Theory Of Productivity", _International Journal Of General Systems, 5_, 1979, pp. 17-30.

8. Olson, Margrethe H., and Lucas, Henry C. Jr., "The Impact Of Office Automation On The Organization: Some Implications For Research And Practice", _Communications Of The ACM, 25_, 1982, pp. 838-847.

9. Strassman, Paul A., _Information Payoff, The Transformation Of Work In The Electronic Age_, The Free Press, New York, N.Y., 1985.

10. Torrance, G.W., Boyle, Michael H., and Horwood, Sargent P., "Application Of Multi-Attribute Utility Theory To Measure Social Preferences For Health States", _Operations Research 30_, 1982, pp. 1043-1069.

11. Urban, Glen L. and Hauser, John R., _Design And Marketing Of New Products_, Prentice-Hall, Englewood Cliffs, N.J., 1980.

12. Zmud, Robert W., "An Empirical Investigation Of The Dimensionality Of The Concept Of Information", _Decision Sciences 9_, 1978, pp. 187-195.

Faculty of Business

McMaster University

WORKING PAPERS - RECENT RELEASES

221. Joseph B. Rose and Gary N. Chaison, "The State of the Unions: United States and Canada", April 1984.

222. Naresh C. Agarwal, "Economic Costs of Employment Discrimination", May 1984.

223. R.J. Adams, "Estimating the Extent of Collective Bargaining in Canada", May 1984.

224. Robert G. Cooper, "New Product Strategies: What Distinguishes The Top Performers", May 1984.

225. Norman P. Archer, "Selection of a Simulation Language for an MBA Modeling and Simulation Course", June 1984.

226. Robert F. Love, William G. Truscott, John H. Walker, "A Facility Location Decision: Thibodeau-Finch Transport Ltd.", June 1984.

227. R.J. Adams, "Two Policy Approaches to Labour-Management Decision Making at the Level of the Enterprise: A Comparison of the Wagner Model and Statutory Works Councils", July 1984.

228. George Saunders, "Employment and the Productivity Slowdown 1958 to 1980", September 1984.

229. George Saunders, "Industrial Relations in Canada", September 1984.

230. George Saunders, "Wages and Interest Arbitration: A Case Study of the Canadian Federal Public Service", September 1984.

231. Norman P. Archer, "Optimal Control of an Ornstein-Uhlenbeck Diffusion Process, with Applications", November 1984.

232. Robert G. Cooper, "Selecting Winning New Product Projects: The Newprod System", January 1985.

233. R.J. Adams, "Industrial Relations and the Economic Crisis Canada Moves Towards Europe", January 1985.

234. G. John Miltenburg and Itzhak Krinsky, "Evaluating Flexible Manufacturing Systems", January 1985.

235. G.J. Miltenburg, "The Transient Behaviour of Transfer Lines With Buffer Inventories", February 1985.

236. Paul D. Dowling and Robert F. Love, "An Evaluation of the Dual as a Lower Bound in Facilities Location Problems", March 1985.

237. Min Basadur, George B. Graen and Terri A. Scandura, "Improving Attitudes Toward Creative Problem Solving Among Manufacturing Engineers", March 1985.

238. Christopher K. Bart and Roderick E. White, "Managing To Make Business Unit Strategies Work", May 1985.

239. Harish C. Jain, "Sexual Harassment: Issues and Policies", June 1985.

240. George Steiner, "Searching In 2-Dimensional Partial Orders", July 1985.