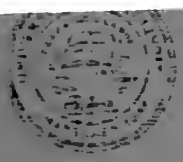

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Measuring the Value of an Information System

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Abstract

In a system conversion, the economic feasibility of a new information system is based on its performance and costs advantages over an existing system. The performance advantage normally consists of an increase in revenue or economies in operations achieved by the implementation of the system. The cost advantage consists of savings realized in the cost of running the system. While it can be predicted with some accuracy in many cases, whereas the performance advantage can be predicted only in qualitative terms in most cases. As a result, the decision to implement a new system is usually based on its cost advantage alone. The assessment of the performance advantage may have to wait until after the system has been used for a period of time. Even in this case, its accurate assessment is difficult, as is shown by a case discussed in this paper.

Measuring the Marginal Value of an Information System[1]

Introduction

An information system is usually evaluated on its net value, the difference between its total benefit and its total cost. The total benefit consists mainly of the value of information produced by and operational benefits, usually cost savings, derived from the system. According to the economic theory of information, first proposed by Marschak [4] and subsequently expanded by a number of authors such as [2] [6] [8] [11], information is a probabilistic variable that explains the state of a decision problem and therefore specifies a course of action to take. Two of the underlying assumptions of the theory are that attributes of information--such as relevance, timeliness, preciseness, accuracy, and completeness--are measurable, and that the outcome of a decision based on their measurements is given by a known distribution.

Unfortunately, these assumptions are rarely operational in reality, and therefore accurately predicting the value of an information system is difficult at best and impossible in many cases. To alleviate this difficulty, some authors have suggested nonanalytical methods to evaluate an information system, such as simulation models, laboratory experiments, and subjective performance evaluation [1] [3] [5] [7] [9] [10].

In the majority of cases in industry, a new information system is implemented to replace an existing system. In these cases, the selection of the new system is based on its total benefit consisting of

its performance and cost advantages over the existing system. The performance advantage consists of an increase in revenue and various operational economies achieved by the implementation of the system. The cost advantage is cost savings realized by the system in performing the same functions used be performed by the existing system, taking into consideration the new system's initial development and annual operating costs. Although both the performance and cost advantages should be included in the economic feasibility of the system, the former advantage is much more difficult to assess in practice than the latter. Authors of the system development methodology often emphasize the importance of a post-implementation study to evaluate, among other things, benefits actually realized by the implementation of a new information system. In reality, however, even after an information system has been used for some years, proper operational data to substantiate its performance advantage may not be available at the firm.

The difficulty of accurately predicting the performance advantage has made it a common practice in industry to select an information system on the notion of cost minimization since the early days of using computers in business [9]. This selection usually proceeds in two steps: first, it gets proposals for several alternative systems that satisfy all user requirements; and second, it finds among the alternatives a system with a minimum cost. In this selection, anticipated benefits associated with each system are usually listed as intangibles and may be used to break a tie between systems with similar costs. However, this approach may sometimes result in an extremely conservative estimate of the net benefit of a new information system.

This paper presents such a case in which the performance advantage far exceeded the cost advantage of a new information system for processing sales orders implemented at an industrial firm.

2. Organization investigated[2]

The subject of this study is Kao Corporation, the largest producer of laundry products in Japan. Kao was divided to two major product groups, the industrial-chemical group and the consumer-product group. This study concerns the consumer-product group whose products were produced by six factories and distributed by 80 distributors to some 240,000 retailers.

During the period of 1975-77, Kao converted the existing manual order processing system to an online system using a computer network; the conversion was carried out in several stages at each of which a new group of distributors was covered by the system. To investigate the full impact of the system conversion, we collected operational data in FY 1975, just before the conversion, and those data in FY 1981, a few years after the completion of the conversion. As listed in Table 1, Kao's gross revenues from operations in FY 1975 and FY 1981 were $744.3 million and $985.9 million, respectively. Of the gross revenues, those from consumer products represented 82.6 percent in FY 1975 and 84.3 percent in FY 1981.

In the old system, distributors sent orders to Kao by telephone. These orders were received by twenty-one clerks in the sales order processing group who transcribed the orders to shipping order forms. These forms were sent to the order entry group, where thirteen keyboard operators punched the shipping order data onto paper tapes. The tapes

were later rung on a paper-tape reader to transmit the data to a Univac 1106 in the computer center. In 1975, the system processed a total of 153,624 shipping order forms with 395,136 items. In those days, Kao had no idea about the inventory of products available at the warehouse of each distributor. Since the distributor determined the quantity of each ordered product on the basis of anticipated demand dampened by inventory on hand, Kao could not accurately determine existing demand for the product at the retailer level. Although Kao subscribed the Nielsen market survey, it found the survey's two-month old data on market demand practically useless.

In the new system, an identical minicomputer was installed at each distributor and connected with the host computer, a Univac 1100/81, installed at Kao's computer center. Prior to the implementation of the new system, in a radical departure from the traditional arrangement between the producer and the distributor, Kao leased the distributor's warehouse to maintain its own inventory for the distributor. But the handling of products in the warehouse was done by the distributor's personnel as before. A warehouse clerk entered the quantities of products shipped out to retailers into the minicomputer system from an online terminal. The quantities thus entered were accumulated in a transaction file in the system during business hours and summed up by product at the end of the day. The summary data were transmitted through a telephone line to the host computer system to update the distributor's inventory record in an online file. When the updated quantity of a product in the inventory record dropped below a minimum acceptable level, the system printed out a shipping order through an

online printer at the factory to deliver an optimum quantity of the product to the distributor.

3. Benefits of the new information system

The new system eliminated the needs for manual tasks for sending, receiving, and processing orders. As a result, the system conversion enabled Kao to reduce order-receiving clerks from 51 to 34 and eliminate 13 data-entry clerks. This reduction in clerical manpower was no doubt the main justification for implementing the new system.

The main interest of the present study, however, is to assess various benefits gained by the new system. Since the new order processing system used a computer network connecting Kao with distributors, its benefits should include those available to Kao and distributors. The new system provided Kao with accurate information on inventory available at the distributor's warehouse and timely information on daily demand for Kao products at the retailer level. Consequently, it enabled Kao to make a better forecast on the market demand and closer control of inventory at the distributor's warehouse than before. Also, the automatic processing of sales and shipping orders practically eliminated the shipment of wrong products to the distributor which had been headaches to both parties. Further, the improved control of inventory reduced the number of daily stockouts at the distributor's warehouse. To summarize, the benefits gained by the new system are, among other things, the following three:

1. A reduction in total inventory of products carried by Kao and its distributors.

2. A reduction in frequency of wrong products being shipped to the distributor.

3. A reduction in number of daily stockouts at the distributor.

Each of the above benefits will be examined next and, where possible, its magnitude will be estimated by assuming a linear relationship between cost and revenue.

(1) Reduced inventory

Prior to the implementation of the new system, Kao bought back the entire inventory of products in the warehouses of the distributors. To generate the revenue of $614.8 million in 1975, the firm had to maintain an average monthly inventory of $54.6 million at cost that consists of $35.0 million and $19.6 million, representing the inventories in the warehouses of the factories and distributors, respectively, as listed in Table 1. If the same old system were used to generate the revenue of $831.1 million in FY 1981, the following total inventory would have been required:

$$54.6 \times \frac{831.1}{614.8} = \$73.8 \text{ million}$$

Therefore, the reduction in inventory achieved by the system conversion is an impressive rate of 25.1% as given below:

$$(73.8 - 55.3) \div 73.8 = 25.1\%$$

The average rate of interest[3] on Kao's bank loans in 1981 was 7.5 percent. At this cost of money, the estimated saving in inventory carrying cost in FY 1981 due to the new order processing system is:

$$(73.8 - 55.3) \times 0.075 = \$1.388 \text{ million.}$$

(2) Reduced shipping errors

To determine the distributors' experience on receiving wrong products from Kao and having stockouts in daily operations, data were collected at a distributor with a revenue of $19.996 million in FY 1981, representing about an average revenue among the 80 distributors (see Table 4). The conditions of this distributor were considered to represent the average conditions of all distributors, since the new system handled all distributors' inventory and logistic problems in identical manners. Before the implementation of the new order processing system, the distributor received 30 items per truck load and found an average of one item in error. Under an agreement with Kao, unlike the normal business practice, the distributor retained the wrong items but requested Kao to promptly ship out the correct ones. Thus, the only penalty imposed on Kao was the reprocessing of these orders, and the distributor was obliged to carry the inventory of products not needed immediately. We could not assess the cost of this inventory, because the distributor did not have proper operational data for the assessment.

The total processing cost of the old order processing system in FY 1975 was $1.423 million (see Table 3). To simplify our analysis, we assume linear relationships between number of ordered items and order processing cost and between order processing cost and revenue. If the old sales order processing system were in use when the revenue of $831.1 was generated in FY 1981, the redundant processing cost would have been

$$1{,}423{,}000 \times \frac{831.1}{614.8} \times \frac{1}{31} = \$62{,}053$$

On the other hand, the distributor found only one wrong item in an average of 113 truck loads received per month under the new system. Each truck carried an average of 20 items in FY 1981 instead of 30 items in FY 1975 because of the rationalization of carton size instituted between the two years. The total annual cost of order processing by the new system in FY 1981 was $1,312,000 of which the variable segment was $986 thousand consisting of the total personnel cost of $586 thousand for processing orders and the EDP Center cost of $400 thousand (see Table 3). Assuming again the linear relationship between number of ordered items and processing cost, the estimated cost of redundant processing due to shipping errors in FY 1981 is

$$986{,}000 \times \frac{1}{113 \times 20 + 1} = \$436$$

Thus, the use of the new system, instead of the old one, realized the following estimated saving in order reprocessing cost:

$$62{,}053 - 436 = \$61{,}617$$

(3) Reduction in the number of back-orders

On the average, the distributor experienced about 4 stockouts per day when it was carrying a total of 220 items in FY 1975. In FY 1981, it carried 350 items and experienced on the average 5 stockouts per day. By assuming that the number of stockouts is proportional to the total number of items in inventory, the distributor might have had the following number of stockouts per day if the old system were used in FY 1981:

$$4 \times \frac{350}{220} = 6.4 \text{ items/day}$$

In FY 1981, the distributor actually experienced 4 stockouts per day instead of the estimated number of 6.4 because of the improved inventory control by the new system. However, available operational data were insufficient to assess the economic value of this improvement.

4. Conclusion

In most cases, a new information system is implemented to replace an existing one. Its economic feasibility is usually based on its total benefit consisting of its performance and cost advantages over the existing system. The performance advantage is extremely difficult to anticipate before the use of the system, and cannot be accurately evaluated even after the system has been used for some years because of the lack of operational data useful for this purpose.

In this study, we have tried to assess the total benefit of a new system in a system conversion taken place at Kao Corporation. The conversion completed in 1977 was from a manual order processing system to an online automatic order processing system using a computer network. With the linear relationship assumed between cost of order processing and revenue, the annual savings in FY 1981 in total cost of order processing realized by the system conversion is estimated to be

$$1{,}423 \times \frac{831.1}{614.8} - 1{,}312 = \$612 \text{ thousand}$$

On the other hand, the new system produced the following, performance advantage consisting of the estimated reduction of $1,388 thousand in inventory carrying cost and that of $62 thousand in cost

of order reprocessing:

1,388 + 62 = $1,450 thousand

The estimated performance advantage of $1,450 thousand is substantially greater than the estimated cost advantage of $612 thousand in order processing. This is a noteworthy result when the original decision for the system conversion was based mainly on the savings of $612 thousand because there was no agreement among management regarding possible benefits in performance to be gained by the new system.

NOTE

[1]The author wishes to express his appreciation for cooperation received from Kao Corporation in collecting data necessary for this study.

[2]All economic units in this paper are in 1981 dollars.

[3]This rate is the weighted average of regular loans from commercial banks listed in the FY 1982 full security report of Kao Corporation (YUKASHOKEN HOKOKUSHO SORAN) published by the Japanese government; the report corresponds to FTC Form 10-K.

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Table 1

Operational Data in Two Fiscal Years[1]
(Units in Millions of 1981 Dollars)

	FY 1975[2] (April '74 - March '75)	FY 1981 (April '80 - March '81)
1. Gross revenue of two groups	$744.3	$985.9
2. Consumer product group		
(1) Gross revenue	$614.8	$831.1
(2) Finished goods inventory valued at their costs (Monthly average for the year):		
a. Kao's warehouses	35.0	
b. Distributors' warehouses	19.6	
c. Total	$ 54.6	$ 55.3

[1]All dollar values have been converted from values in Japanese yen at a rate of $1 to 256 yen, a typical rate in 1981.

[2]Values in FY 1975 have been adjusted to values in 1981 prices with Average Wholesale Price Index.

Table 2

Costs of Personnel in Two Systems
(Units in Thousands of 1981 Dollars)

Type of Personnel	Number of Personnel		Average Salary in FY 1981	Total Salary at FY 1981 rates	
	Old System (FY 1975)	New System (NY 1981)		Old System (FY 1975)	New System (FY 1981)
1. Order processing and distribution					
a. junior clerks	40	16	$13.67	$546.80	$218.72
b. senior clerks	7	14	19.53	136.71	273.42
c. supervisors	4	4	23.44	93.76	93.76
Total	51	34		$777.27	$585.90
2. Data entry a. keying clerks	13	0	13.67	$177.71	$ 0
3. All personnel	64	34		$954.98	$585.90

Table 3

Total Annual Costs of Order Processing by Two Systems
(Units in Thousands of 1981 Dollars)

Cost Item	Old System (FY 1975)	New System (FY 1981)
1. Personnel cost for order processing and data entry[1]	$ 955	$ 586
2. EDP Center cost:		
a. Total cost[2]	$2,339	$2,364
b. Percent applicable to order processing	20.0%	16.9%
c. Order processing cost	$ 468	$ 400
3. System development cost		
a. Total cost		$ 482
b. Capital recovery factory[3]		29.6%
c. Annualized cost[4]	0	$ 143
4. System maintenance cost[5]	0	$ 183
5. Total annual cost of system	$1,423	$1,312

[1]See detailed figures in Table 2.

[2]The total cost covers hardware and software lease, data transmission, and personnel.

[3]The percentage is derived from an estimated life of 6 years at a discount rate of 19.3%, the firm's average rate of rturn on equity capital before tax during the period of 1976-81.

[4]The cost of the old system has been completely written off.

[5]The cost of the old system is included in EDP center cost.

Table 4

Data on Wrong Items Being Shipped and Stockout Items*

		FY 1975	FY 1981
(1)	Number of items carried	220	350
(2)	Number of stock-out items	4 per day	5 per day
(3)	Rate of wrong items	1/30	1/2260
(4)	Rate of redundant order processing	1/31	1/2261
(5)	Total annual cost of order processing	$1,423,000	$1,312,000

*Data were obtained from the distributor in Kyoto with a revenue of $19.996 million in FY 1981.