A Framework for Improving the Quality of Management Information

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ABSTRACT

Computer-created information is rapidly becoming too great for executives and others to absorb. The quality of information must therefore be enhanced to provide business managers with appropriate information to make efficient decisions. This paper presents the findings of a study to clarify the main and supportive attributes of quality information and the computer tools that support the production of such information. The study presents a framework for the evaluation of the most appropriate computer equipment and applications that would lead to the improvement of information quality in a particular organisation.

INTRODUCTION

Computing in business has developed from the mechanical processing of limited sets of data some ninety years ago to a highly sophisticated electronic tool to manage business processes from the very small too the extremely large. Organisations find themselves today in the sixth major generation of computers in forty-three years (Edmunds, 1987:109). Computers have become an integral part of success in business. In order for business to survive industry competition in the 1980's and into the 21st Century the use of computers must be part of business strategy (Griffiths 1986:184).

The expanded scope and diversity of information systems and the infiltration of information technology into every facet of business mean that information management cannot be confined to the data processing arena - it is a corporate-wide affair. Hammer, chairman of one of the largest banks in the United States,

regards the corporation's three fundamental assets as people, capital, and information systems (Griffiths, 1986:185). As a resource, information is unique. Unlike most resources, information is not exhausted by use, rather its value can be increased by its circulation (Longley, 1982:165). The price-performance ratio of technology has also improved many times over and is still improving. The use of information warrants more attention as many more people in the wider community outside data processing departments began to make use of technology (Griffiths, 1986:186).

Initially the focus of computers was on the processing of data. In the 1970's the awareness of the significance and value of information became more evident. The mere processing of data shifted to the compilation of information for management. Growth in the size of organisations and an increase in the number of managers demanded a wider distribution of information within shorter periods. This caused information to expand rapidly. According to Murdock, 75% of all information available was produced in the last two decades (Murdock, 1980:4). Users are finding it difficult to cope with the overload of information. Adams said that "computer-created information is rapidly becoming too great for executives and others to absorb" (Adams, 1977:7). The apparent overload caused by the vast volumes of information demanded in turn the development of new technology to improve the capabilities of handling this information.

The growth in the computer industry has been phenomenal. Forty years ago there were virtually no computers, now the computer industry is the fourth largest industry in the world, with over three thousand firms (Awad, 1988:55). Computers offer an ever increasing variety and complexity of products, technologies and developments. The technological development emphasises the production and manipulation of ever increasing volumes of data and the presentation of acceptable information for management decision making. More recent developments include database management systems, advanced and more user-friendly programming capabilities, hypermedia, powerful processors and expert systems. A major technological trend is the convergence of computer and communication technologies. All these developments enhanced the users' ability to obtain better information for decision making.

Complex alternatives such as the choice between processors, software development platforms, and networking topologies are available to management to select suitable equipment, applications and the appropriate technological environment to produce acceptable results. Because of the complex relationship between different alternatives and the impact it could have on the production of information, it is no simple task to produce the information required at the right

place, and at the right time. This wide variety of tools available to collect, manipulate and produce information, presents a potential problem to management. Selection of alternatives is often made for reasons other than the production of good quality information, such as price or processing power. The contribution that specific equipment and computer applications could make to improve the quality of information should be considered to help management with the appropriate selection and application of computer technology.

OBJECTIVES

It was against this background that a study was undertaken with two main focus areas: computer tools and quality information. It aimed at bringing the interrelationship of these focus areas together.

The first focus area of this study was information. The study of information is contained in several scientific disciplines including: Information Management, Psychology and other human behavioural sciences, Computer Science, and Business Science. This study approached information from a very specific angle. It focused on the attributes of information in a business environment. It considered the background, nature, and features of electronic information in business produced by formal electronic information systems.

The second focus area was the computer equipment, applications and technology environment which produce information. Computers and related technologies are very wide subjects. They are covered by Computer Science, Electronic Engineering, and Management Science. This study did not elaborate on all aspects of computer equipment, types of applications and technologies in the computer environment. It concentrated on those aspects that relate to the processing of data and the production of information.

Finally, the study considered the impact that the components of computer systems have on the value of information. Many other factors, beside computers could affect the value of information. For example, the ability of the information user to define, interpret and react appropriately on the information could greatly affect the value of information. Another factor determining the value of information, is the source data. The quality of the source data will have a direct impact on the quality of information. Notwithstanding the impact that other factors might have on the value of information, this study concentrated on the impact that computer equipment and applications have to produce quality information.

Hypothesis

Quality information is that information that can have a decisive impact on the decisions and actions of the decision maker. This study submitted that it is feasible to identify the attributes of quality information and clarified the main and supportive attributes of such information.

Computer equipment and applications, collectively known as computer tools, used and managed in an organisation contribute to enhance or impair quality information. This study considered these tools and the role they play to support the production of quality information.

The hypothesis was defined as follows: using the most appropriate computer equipment and applications, and managing the optimisation of the features of these tools would lead to the improvement of information quality.

RESEARCH METHOD

The research method of the study unfolding the hypothesis, is illustrated in Figure 1.

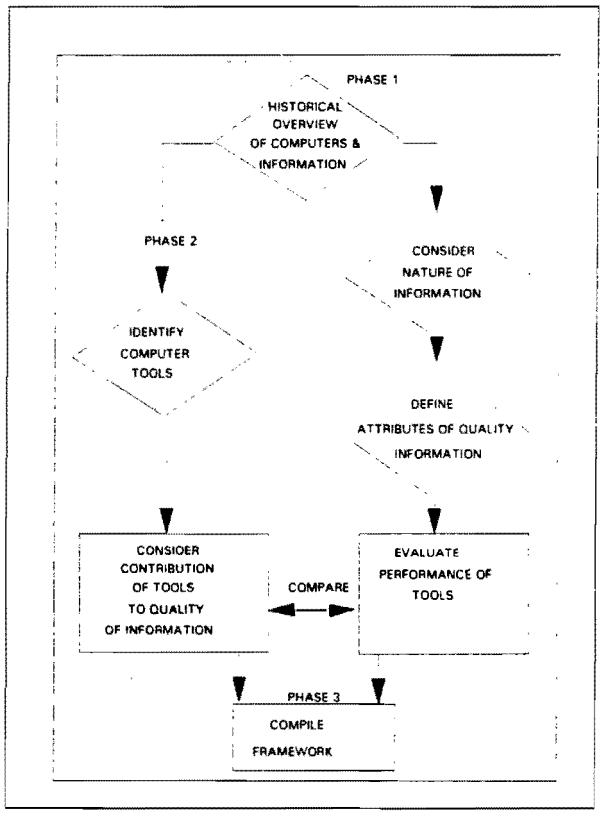
The research method included the following steps:

A comprehensive literature study and synopsis of the historical development and trends of computing concluded with a summary of the main driving forces behind computer development.

The overview of the nature and characteristics of business information and the identification and compilation of the attributes of quality information isolated the main attributes and gave assurance that the attributes identified are comprehensive.

The study classified the computer equipment and applications, collectively called tools, into logical groups. To ensure that a comprehensive review was done of all applicable tools that might influence the production of information, an extensive survey off computing topics was done in the literature. An assessment of the potential contribution that each group of tools identified in the step above could make to improve the attributes of quality information was then done. The characteristics of the tools and the attributes were analysed to deduce an acceptable method of assessing each tool's contribution to the production of quality information.

Figure 1 - Overview of research method



To evaluate the significance of the attributes, the elements of information were refined into measurable components. The definition of these measurable components of information is described later in this study.

A framework was then compiled to be used by managers to analyse information components and to identify areas of improvement to produce better quality information.

OVERVIEW OF COMPUTER DEVELOPMENT DRIVING FORCES

The literature study of the historical development and trends of computing covered computer development from the early days in the eighteenth century, to the current sixth generation of computers. The synopsis of the developments showed that a combination of key forces caused change in the computer world. Research and development opened up new possibilities. The immediate needs of society at a particular point in time, consumed the ideas of the scientists and inventors to create viable products. Research also created new opportunities to solve new problems. Factors which increased the pressures on researchers to produce better results included changes in the scales of economy, developments in areas like communication, human behavioural research, and electronics and many other disciplines.

During the last forty years, the main forces behind the direction in which computers developed can be summarised as follows:

- The profit motive of a major industry in the world;
- increased processing power of smaller and smaller "engines";
- the widespread use of computers in all areas of life;
- the connectivity of computers throughout the world;
- the storage capacity of data and information for many uses.

The driving forces behind the developments in the six computer generations, with the major benefits and shortcomings of each phase, are summarised in Table 1.

Table 1 Driving forces

PHASE	DRIVING FORCE	PRODUCTS & BENEFITS	SHORTCOMINGS
Early days 1800-1950	- natural desire to account for wealth and possessions - government requirements - increased size of businesses - creative forces to build calculating machines - World war 2 demand for faster computations - research	- replacing mundane tasks performed by humans - adding machines - arithmometers - mass production of data - building of powerful processors - productive programming - relation between human thinking and computer achieved	- limited stored programs - enormous computers - no communication between computers - no networking - limited reliability
First Generation 1951-1958	- advances in processor technology - awareness of scientific importance of computers to universities - putting more power into programming - systems to operate remotely	- birth of information age - faster processors - first digital commercial computer - FORTRAN developed - commencement of multiprogramming - experimentation with interactive systems and timesharing	- bulky and inflexible - used vacuum tubes for memory - required air-conditioning - handled one program at a time - programming performed in machine language
Second Generation	- cost reduction in accounting applications	- front-end processors and remote communications	- little realisation of potential of software

Table 1 (continued)

Second Generation 1959-1964	- cost reduction in accounting applications - need to use data communication - multi processing - transistors replacing vacuum tubes - magnetic core memory - upcoming data processing professionals	- front-end processors and remote communications - symbolic programming languages - development of COBOL - EDP managers move up in organisation - typical applications: payroll, accounts receivable, accounts payable, billing	- little realisation of potential of software - no software industry - management lax in full utilisation of EDP resources - no charge back of EDP costs to users - lack of flexibility
Third Generation 1965-1970	- applications in all functional areas - exponential demand for computer use - appearance of software houses - growth in size of organisations and economy	- integrated circuits - improvements in speed, capacity, types of input/output, storage devices - mini computers - Typical applications: general ledger, forecasting, budgeting, inventory control	- primarily concerned with record keeping and data processing - management information not common - high maintenance and development costs - poor documentation - high demand for programmers

Table 1 (continued)

Fourth Generation 1970-1980	- expansion of information production and needs - complexity of economy and enterprises increased - further growth in number of managers and other users - emphasis on quantitative techniques in management - controlled application development - EDP funds tightened - emphasis on user needs - explosion in use of communication based systems - requirements for integrity, availability and reliability	- significant improvement in design and performance - large scale integrated circuits - micro computers - Database management systems - move towards centralised computing - controls and standards enforced - restructuring of application portfolios - surge of application software packages - greater involvement of users - databases and distributed computing appear - user base expansion	- little inter-organisational communication - dependence on user programming - limited use of micro computers

Table 1 (continued

Fifth Generation	- user machine interface - expert systems - networking - distributed processing - client-server technology - communication - wide range user support - graphical developments - human computer interaction	- VLSI architecture - parallel processing - office automation - micro computing for single users and networks - user-friendly packages - decision support systems - experimental work in expert systems - end user computing - graphics	- explosion of information - expectation gap between users and DP departments - technology explosion - user machine interface under developed - expert systems not commonly used - use of advanced technology limited - pressure on capabilities
Sixth Generation	- expert systems - machine translation systems - intelligent robots - cross disciplinary research e.g. physiology, psychology, linguistics, logic etc. - speech handling - vision - world wide communication	- total integration of computers - comprehensive information provider	- intuitive reasoning - associative recall - creativity - hearing - smelling - feeling - tasting - emotion - gestures

THE MAIN ATTRIBUTES OF QUALITY INFORMATION

The literature study revealed a very haphazard coverage of the attributes of quality information. Some 62 adjectives, used by authors to refer to the attributes of information, were identified. Most of the authors referred to 'relevancy', 'accuracy', and 'timeliness' being important attributes. Several other adjectives relate to these.

Other adjectives relate to the ability of the user to understand and work with the information. Although the ability to comprehend the information is closely associated with 'relevancy', there is a distinct difference between the two. 'Relevancy' has to do with the content of the information. 'Comprehension' has to do with the interface between the user and the information. No single concept was defined in the literature as the dominant collective term for the attributes referring to these two aspects. For the purposes of grouping all these adjectives together, "comprehensibility" is used.

The four main attributes identified in the study: relevancy, accuracy, timeliness and comprehensibility, and the other adjectives associated with them are summarised in Table 2.

Table 2 Attributes of quality information

Main Attribute	Sub-Attributes	
relevancy	sufficient detail	ability to manipulate
	not too much	acceptable
	not too little	accessible
	comprehensive	available
	appropriate	adaptable
	closeness to problem	ease of access
	flexible	pertinence
	support decisions	meaningful
	authorised	fitness
	degree of integration	selective
	complete	
accuracy	limited noise	credible
	verifiable	reliable
	precise	valid
	freedom from bias	
timeliness	at the right time	current
	not too late	on schedule
	on priority	out of time
comprehensibility	readily understood	ease of use
	adequately presented	output quality
	clarity	quantifiable
	reproducible	simplicity
	understandable output	user friendly

The significance of the main attributes are discussed in the following paragraphs.

Relevancy

Information is constantly accumulating, having reference made to it and being stored. It can be a Frankenstein monster if not controlled. Too much in store can be self-defeating, but too little causes the decision makers and problem solvers to operate without true knowledge of what they are doing. To be kept under control, information must first be analysed and categorised to ensure useful benefit to all potential users. According to Whitehouse information is knowledge; rapid and easy access to the right knowledge is intelligence (Whitehouse, 1971:2). It must be available in sufficient detail to meet the needs of the user.

All information progresses from new to old and will be lost if not consciously preserved. Too much information gives retrieval problems, so information must not only consciously be preserved but must be consciously destroyed (Whitehouse, 1971:3). The information retained must be appropriate for the users, and sufficiently close to the problem to be pertinent.

Vast quantities of information are produced, more than any person can possibly need or use. A person's brain filters most of the data, and is consciously aware of it, but acts upon only a tiny fraction of it. The objective is for a management information system to be so constructed as to filter out unneeded information, and to convey only the information that supports the needs of the decision maker. The difficulty is that designers of information systems cannot know exactly what information will be relevant to an organisation. The challenge is to assess the relevancy, and to provide appropriate access to it.

To be relevant, the information must apply to the action or decision to be considered. It must be close to the problem, not over-presented information but have sufficient detail and be flexible enough to provide for all the alternatives to be considered.

Two users facing the same decision might use completely different information to arrive at an acceptable conclusion. For example two managers face a decision to increase production volumes. The one will primarily use production statistics and sales volume information; the other will largely base his decision on market trends, the age of the plant and equipment and make his final decision because it will please his boss. Appropriate relevancy is therefore primarily dependant on user preferences.

Only when the information is available in a required form or place, can it become relevant. Non-existing information cannot be relevant. Information however, can be incomplete and have a low quality. The degree of fit in a

particular situation is largely dependant on the process of filtering irrelevant information, and providing easy access to that which is relevant.

Because of the developments in information technology, there will be a marked increase in the quantity of rapidly accessible information and the ability to manipulate it (Longley, 1982:165). This will not necessarily improve the relevancy of the information. Facilities must be provided to get the right information at the right time.

Accuracy

Any communication channel contains some background activity, which is called noise. Information can only be recognised on the channel if it transmits signals stronger than the noise. The theory of noise in a communication channel and methods to minimise it, is well established in natural sciences. It is more difficult to determine noise in management systems. However it does exist and because it can never be eliminated, measures to improve the clarity of the messages in a management system are worthwhile to be considered.

With each message the relevant question is whether the information is a close enough approximation to reality for the intended purpose.

Deciding the accuracy of information depends on the nature of it. Usually accuracy is associated with quantitative information. There are two types of quantitative information: counts and measurements. Counts can be precise. A count of twelve stock items is exact, in the sense that it is not twelve and a fraction. A measurement is never precise. Measurements are always approximations. Modern technology has made many measurements very accurate, but a margin of error always remains. Most messages in a management information system are measurements, rather that counts. Inventory quantities may be obtained by counts, but the monetary amount of inventory is a measurement. Measurements of such items as the expenses of an accounting period are likely to be a fairly rough approximation.

Many accounting measurements are also not precise because they are surrogates (Anthony, 1980:127). A surrogate is a substitute measure of some phenomenon that is used because it is not feasible to measure the phenomenon directly. Profit, as defined according to certain rules, is often used as a general measure of a division's performance.

Accuracy can also be associated with non quantitative information. For example, a report on the attitudes of staff in the organisation. The accuracy of the information cannot be measured or counted. It could however be judged by

comparing it with other data, for instance, general knowledge about the staff, or the result of a comparable report.

Mostly, precise measurement is not only impossible, it is also undesirable. The more precise the measuring instrument, the more it costs. There is no point in spending money to increase the precision of measurement beyond the degree of approximation that is needed to make sound decisions.

For information to be accurate, it must be verifiable. To be verifiable, it should be related to other information from the same system, or to information from another system, or even to information such as verbal confirmation, prior knowledge, or 'gut feel'. Although it might not necessarily be precise, it must be credible for the needs of the user. This credibility could be supported by the process of validation, or even beliefs or perceptions. For the information to be valid the user should be able to rely on it.

Some inaccuracy of information is attributable to incorrect data producing unacceptable results. To improve the accuracy of the information, the source data must be improved. Inaccuracy could be caused by noise in the communication channel. This is particularly true when the user is biased towards an expected result and therefore judge the accuracy of the information inappropriately or incorrectly. Noise in the communication channel could also result from a lack of interpretative skills, cultural background, or emotion of the user. Finally information could get lost in a channel during the process of transferring information, for example, from one person to another.

There is a trade-off between precision and timeliness. Often it will take more time to produce more accurate information. Approximate information might be more useful to the decision maker than late, accurate information. Quality information must be accurate, however. The desired accuracy to form quality information is completely dependant on the user and could vary from situation to situation and user to user.

Timeliness

Timeliness simply means that the recipient can get the information when he needs it. When information is not timely, it is usually because it is late. The same piece of information might be too late for one decision maker, and just in time for the other, depending on the priorities.

Information can also be received too early. Receiving it too early might result in the storage of the information until it is used, or even the loss of it when it is eventually required.

An important angle of timely information is related to the time that it takes to produce the information. Preece (1990:7)quotes a study that Licklider had done in 1960, with the following results: "about 85% of my 'thinking' time was spent getting into a position to think, to make a decision, to learn something I know. Much more time went into finding or obtaining information than into digesting it. Hours went into the plotting of graphs and other hours into instructing an assistant how to plot. When the graphs were finished, the relations were obvious at once, but the plotting had to be done in order to make them so." Although this study of Licklider is somewhat old, the problem is still very real.

No information can be regarded to be timeless, a situation where there is no necessity for information to be available at a particular point in time. Every decision has a beginning and an end. The beginning commences when the need for the decision arises, the end when the decision has been made, Every piece of information used for a decision is received within a time frame, which either suits, or does not suit the time frame of the decision. The information is on schedule when it is received or available within the boundaries of the time frame of the decision.

Because of the difficulty of figuring out the exact timing of when the information must be available, and the different needs of users, some information providers lean towards having the information always available on request. For instance, the accumulation of large databases of information which can be queried at any time. This trend is noticeable in document imaging, CD ROM and inter-continental information networks. These trends are indicative that the cost of information storage is less that the cost of not having the information available on time.

Information that is not on time is worthless and makes no contribution to add to the relevant knowledge of the user. For information to have any quality at all, it must be on time. The degree of on time will decide the degree of quality of the information.

Comprehensibility

The presentation of information is vital for the actual grasping of it. It must be presented in a format that could be understood by the recipient. Recipients have preferences, some prefer graphics, some tables, and other numerical data. When information is retrieved it must be presented in a way that will enhance its meaning and ensure rapid assimilation, (Whitehouse, 1971:3).

The presentation must be free from ambiguity, and should contain a clear picture for the actual purposes of the information. The output must be

understandable. Today much is done to make computers more user friendly. This implies that as the interaction between the computer and the user improves, the presentation of information by computer is more comprehensible. Major computer development trends focus on the need for better presentation such as multimedia, graphics, high resolution screens, and Windows.

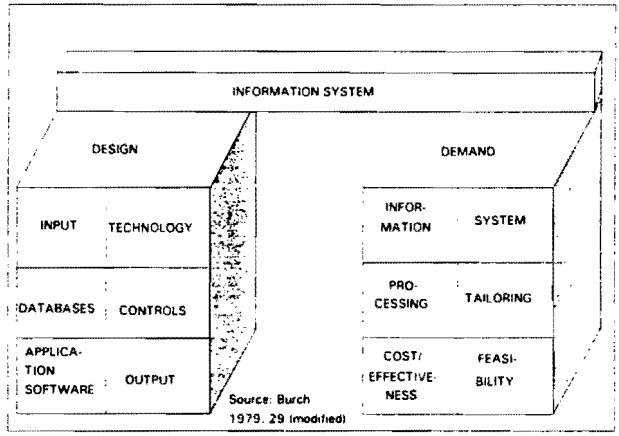
The information must not only be presented, but perceived and readily understood. Without understanding, information would not be converted into knowledge by the user. Understanding is dependant on the quality of the information and the abilities of the user.

Despite the availability of information, or its accuracy, or even its timeliness, without comprehending the information, information will loose the benefit of all other attributes.

SUMMARY OF ASSESSMENT OF COMPUTER TOOLS

The study summarised the computer equipment and applications used to produce information into logical groups. These groups were illustrated as information system building blocks. Figure 2 depicts these building blocks.

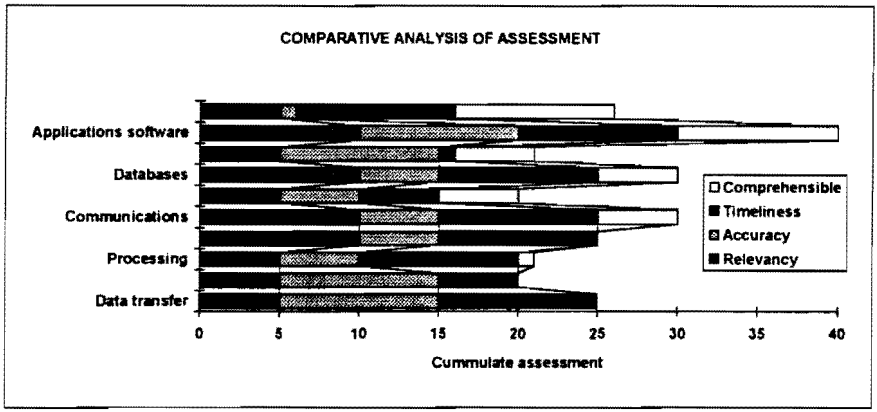
Figure 2 Information system building blocks



The design building blocks: Input, technology, databases, controls application software and output, produce the information. These computer tools were analysed and an assessment made of the contribution that they make to the

production of quality information. The assessment was expressed in quantitative terms and is summarised in a comparative analysis illustrated in Figure 3.

Figure 3 Comparative analysis of assessment



These assessments represent the potential of each building block to improve the attributes of quality information. The results were deduced from an analysis of the characteristics of each group of tools, the identification of the primary objective of the tool group, and the supportive role it played to enhance the quality attributes of information. The reasoning behind each assessment rating was stated in the discussion of each tool group.

It is important to stress that the purpose of the study was not to make an accurate assessment of each individual computer tool. The objective was to create a framework from which the potential contribution of tool groups could be assessed. It will highlight those tools that concentrate on the achievement of specific quality attributes. The assessment would point readers in the direction to find tools that will make the most significant contribution to a specific quality attribute. If the assessment achieves this objective, it can be regarded as a valid and successful assessment.

The following general observations are made from the analysis:

- All tools do not contribute equally to each attribute of quality information.
- The two lowest scorers, controls and software, are both very supportive tools that do not perform primary information production roles.

- All the tools make a good to an excellent contribution to the relevancy of information.
- When considering quality information, the model tools are by far the most significant. It is application programs that make the biggest contribution to enhance all the attributes of quality information.
- In relation to other computer technology development, the technology that enhances the understanding and comprehension of data is relatively immature. It is only in recent years that a major focus has been placed on this deficiency. The analysis illustrates this immaturity and the lack of support of the tools for comprehensibility in relation to the support for other attributes.

INFORMATION COMPONENTS

An information component was defined in the study as the entity to be evaluated for quality attributes. An information component has the following characteristics:

- It is associated with a specific user, or group of users, in a specific organisation.
- It has a homogeneous purpose or objective.
- It demands distinguishable and homogeneous information quality attributes.
- It is a sub set of information.
- It is produced by a specific information system.

FRAMEWORK FOR EVALUATING THE QUALITY OF INFORMATION

Following the assessment of the contribution that computer tools make to produce quality information, the study compiled a framework to be used by managers to analyse information and identify areas of improvement to produce better quality information.

There are four major generic stages to perform an evaluation of the quality of information and possibilities of improvement: Decide what to evaluate, gather the information, analyse the results and choose a plan of action. The following steps were proposed to perform the evaluation and achieve the desired results:

- Select the information area to be evaluated.
- Decide on the information components to be evaluated.

- Obtain responses from users of their assessment of information quality.
- Convert the responses into quality attribute ratings.
- Gather further information if required.
- Match attributes to the potential computer tools.
- Select the tools to work on.
- Design improvement program.
- Carry out improvement program.

Step 1 is necessary to confine the evaluation. It is impractical and virtually impossible to perform an evaluation of all information in an organisation simultaneously. Steps 2-7 will be described in further detail in the next paragraph. Steps 8 and 9 deal with the improvement actions. The study did not deal in detail with these steps.

Step 2: Decide on the information components to be evaluated and improved

Using the main characteristics of an information component as identified in a previous paragraph as a guideline, the information must be reduced into information components. Usually any specific report from an information system in the organisation will comply with the information component definition. By listing these reports and results from the information system to be evaluated this step will be completed. This listing should be done by information system and should contain the following information:

- Short description of information component.
- User or users of the information component.
- Purpose or objective of information component.

Step 3: Obtain responses from users on their assessment of the information quality

Once the information components have been identified, responses can be obtained from the users on their evaluation of the quality attributes for each information component. To simplify responses, a questionnaire can be prepared specifying, for each information component, the attribute and the appropriate scale for evaluation developed in the study.

Step 4: Convert responses from users into quality attribute ratings for each information component

When the responses have been received from the users, each questionnaire must be analysed to identify those information components and attributes in need of improvement. This can be done by putting all the returns into a small database such as Dbase. The record layout should contain the following fields:

- Questionnaire reference.
- Information component code.
- Attribute code.
- Rating.

After all the questionnaires have been captured, the data must be sorted by attribute, by rating and by information component. The result will be that all information components with incomplete information, or all information components received too early will be exposed. By analysing this information, trends can be identified. These will give rise to the type of further information to be gathered.

Step 5: Gather further information if required

It is expected that further information will be required to explain the results of the analysis in step 4. It may be necessary to gather background knowledge of the information systems that produce the information component. It will then be necessary to further investigate certain replies by asking the users for the reasons behind the replies.

Step 6: Match the tools contributing to specific attributes

The first step in homing in on the tools that can contribute the most to improve the quality of the information component, is to use Table 3 to match the attributes to the tools. The result of this comparison must be added to the database questionnaire results compiled in step 4 by adding a field for the most likely computer tool to improve the quality of the information component. If more than one tool is involved, they too should be attached to the record.

Step 7: Select the tools to work on

The database can then be resorted to provide an analysis by tool and by information component. The result will clearly focus the attention on those tools that can potentially improve the information components the most.

The tools that can make the most significant contribution in improving the quality of the information have now been identified. All that remains to be done is to implement the improvements to the tools. This is done in steps 8 and 9.

By following the steps detailed in the previous paragraphs, an organisation can find out which tools to concentrate on to provide the most benefit for improving the quality of information. This will avoid focusing on incorrect areas. For example, there is a perception that the information in an organisation is inaccurate. This would give rise to developing a new information system. However, doing an analysis according to the framework could show that the information is not understood, or that the data capturing should change. Addressing the actual problems can result in substantial savings for the organisation.

CONCLUSION

No major focus on the inter-relationships between information quality and computer tools was evident from the literature study. The study aimed at illustrating the importance of this relationship. Although the effect of computer tools was debated and illustrated, the study did not intend to field test the approach in the information management community. It did, however, add substantial benefit by illustrating the relationship between information quality and computer tools and by refining a framework for evaluating this quality.

The study recognised the different contributions that individual tools within a building block can make to improve the quality of information. To ensure that the focus was not lost with attention to too much detail, the differential contributions of individual tools were ignored. The study focused only on groups of tools. Further studies could focus on individual tools, and highlight those tools' effect on particular developments in technology, which could improve quality information the most.

Another aspect regarding computer tools that the study steered away from, was the effect that one tool group could have on another. For instance, if processing is bad, it pulls down the effectiveness of other tool groups such as applications software. The inter-relationships between tools for producing quality information, could be another important area to study further.

The attributes of quality information were deduced from the study. The literature showed the lack of commonalty among some sixty-two attributes of quality that were mentioned. Empirical studies could further enhance the understanding of exactly what users regard as the most important attributes of quality, and whether those attributes remain static.

Finally, in considering methods to improve quality information, the focus of the study was on computer tools. It was mentioned that the human factor, in enhancing or reducing the quality of information, would be substantial. It was not the intention of the study to focus on this factor. Considering the human factor, and the interaction between computer tools and it, would offer substantial rewards to improve the ability to enhance the quality of information.

The hypothesis was defined as follows: "using the most appropriate computer equipment and applications, and managing the optimisation of the features of these tools would lead to the improvement of information quality."

The study considered quality information and the computer tools that can improve the production of better information. After stating the objectives and research approach, it commenced with an overview of the historical development of computers. From this overview, it is apparent that the last 23 years has brought an ever-increasing focus on the development of improved computer tools to produce more efficient information. The more information that is being produced, the more focus there is on effective storage, manipulation, communication, processing and presentation of information.

The study then examined the nature and characteristics of information pointing towards the decisive impact that information has on the decisions and actions of decision makers. Good information, information that has quality, was then considered. The four main attributes of quality information relevancy, accuracy, timeliness and comprehensibility were clarified. From the literature considered it was evident that a gap exists between information produced by systems and the quality information that users expect. This pointed to the need for improvement in quality information.

The process of producing information from the initial stages of acquiring the data, through processing, communicating, storing, controlling, modelling and outputting the final information was considered. Each building block of the information system, and the computer equipment used, was analysed to find out their effect on the process of producing information. The computer equipment was classified into groups, called computer tools. The potential contribution that these tools can make in improving the quality of information was considered and rated.

A method was developed to evaluate information by dividing it into smaller measurable components, performing an evaluation of the quality attributes of each

component, and finally identifying those tools that could make the most significant contribution towards improving the quality of information components.

By presenting a process of evaluation of quality information, and ways to improve it, by means of a practical framework, the hypothesis was proven. By using this framework organisations can improve the quality of their information, make better decisions and take more appropriate action by using the appropriate computer tools.

It is recommended that this framework be used in an organisation to collect and analyse the information necessary to design a plan of action to improve the quality of information in a specific area.

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