JUSTIFYING INVESTMENT IN INFORMATION RESOURCE MANAGEMENT

Daniel L. Moody & Graeme C. Simsion

Simsion Bowles and Associates,
1 Collins St, Melbourne, 3000.
Telephone: (03) 650 5100

ABSTRACT

Information Resource Management (IRM) is the management of information as a corporate resource rather than as the property of individual systems or users. While many organisations have established IRM functions to address this goal, there has been little formal measurement of their effectiveness. A recent survey of IRM groups in the U.S. showed that only 13% of groups have implemented procedures for measuring their performance. Such measures are essential for justifying the existence of the group, maintaining management support and continuously improving IRM practices. This paper discusses the need to measure IRM effectiveness, identifies key criteria for a measurement program, and proposes some candidate metrics. Further research is in progress to refine these metrics and empirically validate them with practitioners.

INTRODUCTION

Information Resource Management

The goal of Information Resource Management (IRM) is to manage information as a corporate resource, in the same way that other organisational resources such as finance, personnel and property are managed (Henderson, 1987). In the absence of such explicit management, different parts of an organisation are likely to collect their own copies of information and store them in different formats. The costs of an uncoordinated approach include duplication of capture, storage and update effort, and difficulty in consolidating information for reporting. The terms Data Resource Management (English, 1992), Data Administration (Hufford, 1991) and Data Management (Goodhue et al, 1992) are also used for both the philosophy of IRM and the group responsible for implementing it. IRM was ranked as the number two Information Systems management issue in a survey of Fortune 500 IS executives in the U.S. (Neiderman et al, 1991).

Despite the conceptual appeal of IRM, it has had a chequered history in practice. Many organisations that have attempted to implement IRM have either failed or experienced major difficulties (Kahn, 1983; Tillman, 1987; Goodhue et al, 1988, 1992; Lederer and Sethi, 1991). One explanation for this failure is that it fails to deliver tangible benefits to the organisation and quickly loses management support. According to Simsion (1991), IRM objectives are often unclear, activities unfocussed or poorly aligned with objectives, and survival of the IRM group is more often a result of "selling" IRM concepts than of demonstrated benefits.

State of Measurement in Practice

While there is considerable literature on IRM techniques and their potential benefits (eg McKenney and McFarlan, 1982; Martin, 1989; Katz, 1990; Kerr, 1991; Hancock, 1992; Hufford, 1993; English, 1993; Love, 1993), there has been little serious attempt at quantification of these benefits. There are few published cases in the literature of successful IRM efforts, and very few, if any, with benefits quantified in dollar terms. "Success stories" which are regularly presented at industry forums such as IBM's Share-Guide (eg Hancock, 1992) or the Data Administration and Management Association (DAMA), seldom report *quantitative* benefits, and usually represent the only the perspective of the IRM group, which has a vested interest in being perceived as effective.

A recent survey of IRM practitioners in the U.S. (Figure 1) showed that only 13% of organisations had implemented procedures for measuring IRM performance (English and Green, 1991). This was less than the percentage found in a similar survey carried out in 1987. 76% of the respondents had no performance measurement programme in place nor any intentions of establishing one in the near future.

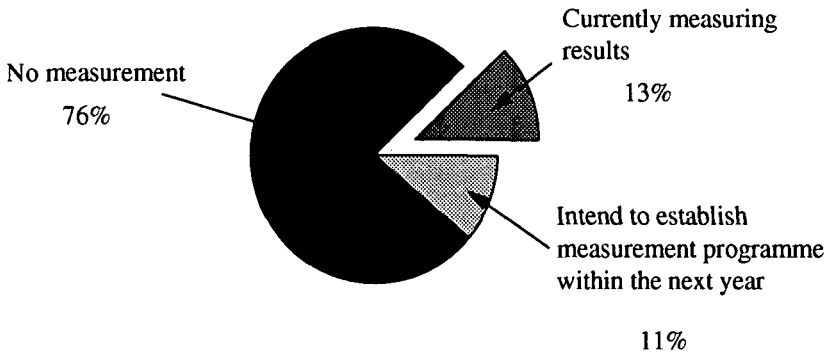

Figure 1. Measurement of IRM Benefits (Source: English and Green, 1991)

English and Green concluded:

> "Although these responses could be interpreted as indicating that IRM is not producing the desired results, or that it is too soon to determine what the impact is, the fact that so little performance measurement has been implemented suggests that the effects of IRM, desired or undesired, actually are not known."

In the absence of any formal measurement of the impact of IRM in practice, the assumption that IRM adds value to the business remains essentially an unproven one. As Strassman (1985) says, "you cannot tell whether you have improved something if you have not measured its performance". Aside from purely anecdotal evidence, there is little to say whether IRM has had a net positive or negative effect in organisations.

Reasons for Lack of Measurement

There are a number of problems involved in measuring IRM benefits that may explain the lack of measurement in practice.

- As with any infrastructure activity, IRM aims to add value to other activities rather than delivering benefits directly. Measurement requires that the contribution of IRM be isolated from other contributions. This is particularly difficult in the situation where IRM staff and project staff are working closely together, and the measurement program requires that only one of the groups be credited with an achievement.
- Another problem is that the benefits of IRM accrue to the organisation as a whole, and are not always visible as improvements in the short term performance of individual business units. Many organisations find it difficult to justify expenditure that cannot be related to specific projects or business areas and which will not produce benefits until some time in the future (Butler Cox, 1991).
- A final problem is that many of the benefits claimed for IRM are intangible or poorly defined. Terms such as "integration", "flexibility", "data availability" and "re-use" require firm definition before they can be measured. The study by English and Green (1991) found that the benefits of IRM cited most frequently were also the least tangible: system quality, system flexibility and user satisfaction. More measurable benefits, such as reduction in development costs, or reduction in end user data entry were rarely reported by the survey respondents.

Another reason for the lack of measurement may be that IRM practitioners do not think that it is important. A Gartner Group survey showed that only 12% of IRM professionals surveyed saw benefit identification as a major challenge to implementing IRM in an organisation (Gartner, 1992). This could be because most IRM managers are from an IT background rather than a business background. Brancheau and Wetherbe (1987) found that business executives consistently considered measurement to be more important than IS executives. IRM practitioners often place far more emphasis on logical arguments rather than economic justification.

The lack of measurement of benefits in the IRM area is indicative of a general problem in IT. It is generally agreed that current IS measurement practices are inadequate and that further development of measures of IS performance are badly needed (Saunders and Jones, 1992). As Merlyn (1992), says:

> "In general, the state of measurement and quantification in MIS is woefully inadequate. Most justification today requires an abundance of faith."

WHY MEASURING THE EFFECTIVENESS OF IRM IS IMPORTANT

Measurement provides a means for particular functions within an organisation to quantify and improve their value to the organisation. Effective measures serve as a framework for defining shared goals and for

communicating how the goals of each function support organisational goals (Walrad and Moss, 1993). Measurement of IRM effectiveness is important both from the perspective of individual organisations, who need to assess the return on their investment in IRM, and from the broader perspective of establishing sound industry practices.

Justifying Initial Investment in IRM

In the past, it may have been sufficient to demonstrate the apparent logic of properly managing information, or to cite the results of past mis-management, in order to convince an organisation to invest in IRM. There is a major emphasis both in the literature and in practice on "selling" the benefits of IRM. As one IRM manager said, "... the marketing of IRM is a continual necessity, particularly in the light of the difficulty in quantifying its benefits." (Green, 1989b). Such approaches are becoming less effective in the absence of well-documented success stories, and the requirement for sound *quantified* business cases to support all IT investment. A study of 31 organisations implementing IRM carried out by Goodhue et al (1988) showed that the successful companies in the sample justified IRM not by conceptual or technical arguments but by compelling business needs.

Survival of the IRM Group

In today's economic climate, organisations are looking to maximise return on investment in all areas of the business, and to cut back in areas that are not directly contributing to profitability. Usually "infrastructure" groups, such as IRM, are the first victims of cost cutting exercises (Simsion and Drummond, 1990). Because they do not contribute directly to the task of delivering systems, they are seen as expendable in times of crisis. The existence of formal measurement of results acts as an effective insurance policy against such a demise.

Management Support

Lack of management support is consistently cited by IRM practitioners as the major reason why IRM does not succeed and as the major obstacle to achieving ongoing success (English and Green, 1991; Martin, 1989). The exercise is more likely to fail from a lack of management commitment than from any technical reasons. Perhaps management are *right* in withdrawing support for a group which cannot justify its value to the organisation. Management will not continue to support a concept that cannot demonstrate measurable benefits to the firm.

Clarifying Goals

IRM groups are often established with a rather vague charter, for example "to manage data as a corporate asset", or "to promote integration and sharing of data throughout the organisation". However it is very difficult to translate slogans into action. As a result, in spite of large amounts of effort and good intentions, they end up achieving very little. Without clearly defined goals and ways of measuring progress against these goals, IRM groups often lack direction and focus. Just the process of defining goals and measures will help IRM groups to define what their charter really means, and clarify the role and function of IRM in the organisation.

Focussing IRM Investment

Measurement of results is fundamental to ensuring that activities are concentrated in areas of most benefit (Darcy, 1994). An IRM group may take a variety of initiatives all aimed at improving the management of information: eg establishing standards for data formats, reviewing database designs prior to implementation, implementing a repository. It is important to be able to measure the effect of each initiative in order to focus resources where they are providing greatest benefit, and to identify problem areas. For example, effort expended on integration should be proportional to the need for integration: in some areas, overheads may be higher than the benefits (Goodhue et al, 1988, 1992).

Ensuring Conformance

One of the major obstacles to the success of IRM in practice is ensuring that development projects conform to the enterprise data model. By itself, an enterprise data model is nothing more than an idealised picture of how an organisation's data should be structured. It becomes valuable only if it is used in practice. Many enterprise data models are ignored after they are completed and the expense put into developing them is wasted (Butler Cox, 1988; IBM, 1992). This is despite conformity to the model being mandated by standards in many

organisations. Project teams seeking exemption from the standards usually do so on the basis that compliance will add extra cost or time to the project. The IRM manager needs to be able to counter this argument with the corresponding costs of failure to comply. The best way to ensure compliance is to promote the benefits of conformance to the enterprise data model rather than by prohibition or policing. In most cases, business managers and systems developers are prepared to make compromises, provided they have a full understanding of the benefits (Butler Cox, 1991).

Improvement of IRM Practices

Measurement is essential for the improvement of processes, whether incremental (eg Total Quality Management approaches) or radical (eg business process re-engineering). Simsion (1991) suggests that many IRM groups do little to review or improve their processes after initial establishment, possibly because of a lack of feedback through measurement. As a result, IRM groups operate based largely on "what ought to work" rather than what has been demonstrated to work. Because methods for implementing IRM are still in their infancy and there are no generally agreed standards or textbooks on the subject, IRM groups should adopt an *adaptive* approach based on experience in practice. IRM groups should review their progress every 6 months or so, and modify their approach if necessary. Measures are necessary to determine whether the approach is working or not and to identify areas for potential improvement.

REQUIREMENTS FOR IRM PERFORMANCE MEASURES

There are a number of key requirements which must be satisfied by any metrics proposed for measuring IRM effectiveness.

Need for Externally Relevant Measures

Measures of IRM effectiveness need to be meaningful to key stakeholders outside the IRM group. Measures such as the number of objects stored in the repository, average number of standards violations to repository objects, the number of subject databases implemented and number of accesses to subject databases per month are often proposed as measures of IRM effectiveness (Green, 1989a). While such measures may assist in the internal management of IRM, they do not assist in determining the value of IRM in meeting IT or business goals. In developing measures, it is important to ask: Who are you measuring for? Who will ultimately decide whether the IRM group has been effective or not? Creating measures which cannot be understood by people outside the IRM group defeats the purpose of measurement, which is to justify the value of IRM to the organisation at large. One of the best ways to ensure the relevance of measures developed is to involve key stakeholders in the process of establishing measures.

Need for Quantifiable Benefits

For maximum effectiveness in getting management support, the benefits of IRM should be expressed in financial terms. This is not always possible, but they should be quantified as far as is reasonable. A common complaint by IRM practitioners is that benefits are intangible and cannot be quantified (Green, 1989a). While there is no doubt that quantification of IRM benefits is difficult, so is justifying expenditure on an advertising campaign, or on research and development, but with some effort it can be done. In most cases establishing measures for intangible benefits is easier than anticipated (Rockart, 1982).
While "hard" quantitative data should form the major part of the measurement process, "soft" measures such as user satisfaction ratings should not be ignored. It is important not to manage on visible figures alone (Zultner, 1992). It may, in some cases, be more appropriate to express some measures in terms of an organisation's key performance indicators, particularly in the case of non-profit organisations whose primary goals may be non-financial.

Need to Consider Both IT and Business Benefits

IRM is unlikely to succeed unless it is seen by top management as critical to the strategic goals of the organisation. This means that IRM must be justified in terms of its relevance to business goals, or support will evaporate when the true costs become apparent, a major project is delayed or when some other business issue diverts their attention. It takes more than recognition by an IT group that integration of data across the organisation is important (Goodhue et al, 1992).

The benefits from an IT perspective are equally important because application developers are the ones who translate IRM concepts into reality. Many IRM efforts have been sabotaged by non conformance in practice because application developers do not support the concept (Apte et al, 1990). Application developers often see having to conform to an enterprise data model as an overhead and need to be given reasons to comply.

Need to Consider Both Short Term and Long Term Benefits

Measurements selected should support both long and short term goals. One of the problems with justifying investment in IRM is that many of its major benefits are realised only in the long term. However especially in the early stages, identification of short term benefits are important to maintain momentum (Butler Cox, 1988). Otherwise management will become disappointed at the apparent lack of progress being made and question the need for the project to continue.
According to Apte et al (1990), securing senior management support is relatively easy because of their long term, strategic viewpoint. But middle level and line managers are far more resistant to the concept because of their short term planning horizon. From the viewpoint of implementing IRM, these managers need to be kept specifically in mind by focusing on short term, project level benefits.

PROPOSED GOALS AND METRICS FOR IRM EFFECTIVENESS

Goals of IRM

The key to identifying appropriate measures lies in identifying what you are trying to achieve (Green, 1989a; Walrad and Moss, 1993). Goals must be defined prior to any consideration of possible measures, otherwise performance measurement may be driven by what you *can* measure (Basili and Rombach, 1987). In order to get the right measures for IRM effectiveness, the goals and objectives of the IRM group must first be clearly defined. Based on a review of the IRM literature and practical experience, we have defined a set of "consensus" goals for the IRM function. We identified eight primary goals, which are shown in the diagram below:

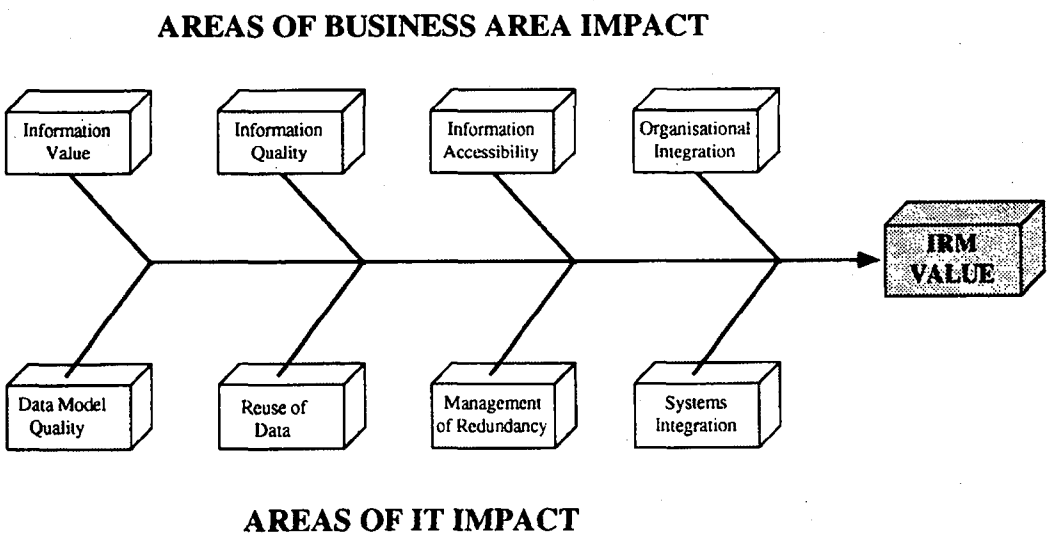

Figure 2. Goals of Information Resource Management

As shown in the diagram, these goals can be classified as to whether their primary impact is on business areas directly, or on IT operations. For example, data quality directly impacts users because it has a direct and visible effect on the accuracy of their decisions. On the other hand, improvements in development efficiency as a result of IRM will show up in IS budgets and productivity figures. In general, improvements in IT operations will ultimately translate into benefits for business users. For example, increasing IT development productivity will affect users in terms of cheaper systems, and faster response to development requests.

Metrics

Finding appropriate measures is the most difficult task in evaluating IRM effectiveness. Cameron (1986) argues that the basic problem surrounding the measurement of organisational effectiveness is not in finding a

theoretical model, but in determining appropriate indicators and standards. It is clear from the literature that IRM practitioners have some notion of what they are trying to achieve and therefore what constitutes effective performance. However these notions are very difficult to operationalise. This paper draws together a large number of research efforts in specific areas (eg. reuse, quality assurance) in order to produce a set of measures which are justified in the literature. This set of metrics is not intended to be complete, but as a starting point, to be refined and extended by further research.

Goal #1: Information Value

As the IRM group is the custodian of the organisation's information resource, the ultimate measure of their success should be the "value" of this resource to the organisation in terms of increased revenue or reduced costs. The result of all their efforts should be to increase the value of the information resource by expanding it, enriching it and finding new ways of exploiting it for business advantage. One of the familiar catch phrases of IRM is that "information is an organisation's most valuable asset and should be managed in the same way as other assets". However unlike other assets, there has been little attempt in most organisations to quantify the value of information. According to Glazer (1993), establishing a procedure for doing so is the primary mechanism by which a firm can integrate IT strategies with business strategies, and successfully use IT for competitive advantage.

Proposed Metrics:

1. Current Value of Information ($). Glazer (1992) describes a method for measuring the value of information, using managerial judgement to estimate the increased revenues or reduced costs to the organisation as a result of having the information (as compared to not having it). A decision calculus methodology is used to assist the managers in arriving at this estimate through an iterative series of questions and responses.
2. Potential Value of Information ($). Glazer (1992) defines a method for estimating the potential value to the organisation of using information (which already exists in the firm or could be obtained) in ways that have not yet been realised in practice.
3. Information Gap ($). This represents the difference between the current actual value of information and the potential value of information. The firm should direct its IT efforts to closing this information gap.

Goal #2: Information Quality

Information quality is defined as the accuracy and timeliness of information produced by information systems. Information quality was ranked third in a study of measures of overall IT performance (Saunders and Jones, 1992). Increasing information quality reduces the amount of time spent resolving data discrepancies, and improves the value of information as a decision making resource (Hufford, 1993). Decisions made based on incomplete, incorrect or out of date information can be very costly to the organisation (Love, 1994). In practice, many important decisions end up being made based on "guesstimates" rather than facts, because information is not available in time to act on it.

Proposed Metrics:

1. End user surveys of data quality (Saunders and Jones, 1993).
2. Customer/client surveys of data quality (Saunders and Jones, 1993). These are individuals external to the organisation who receive information outputs from the organisation eg. statements, invoices.
3. Percentage/size of errors based on statistical sampling of information in databases (Simsion and Drummond, 1992; Morgan, 1994). This metric is directly useful to the business, by giving them an indication of the margin for error they should allow for in their decision making. In most cases, decision makers do not know how reliable the information is and therefore cannot give a confidence level in their decisions.
4. Estimated business cost of errors ($). These costs can be quantified in terms of operational costs (eg. cost of service call to incorrect address), loss of business (eg. as a result of incorrect billing), or the cost of inaccurate decisions (eg. pricing margins).

Goal #3: Information Accessibility

One of the goals of the IRM group should be to increase the accessibility of information across the organisation. Unlike other organisational resources, information is not appropriable, is not depletable (though is often perishable) and generally *increases* in value the more it is used (Glazer, 1992). In most organisations, there is an enormous amount of existing computer based information that could be used to advantage by the business. Research on competitive edge applications by Butler Cox (1991) shows that the majority of such applications arose from new ways of using information stored in existing databases. However the opportunities are not realised because few people are aware of what is available.

Accessibility to information is enabled by the IRM group through the provision of an information catalogue or "data inventory", which maps business definitions of data contained in the enterprise model to databases and files (Devlin and Murphy, 1988; Hufford, 1993; Butler Cox, 1988). This information can be used by both systems developers and users and is one of the ways that an IRM group can provide immediate and tangible benefits to the organisation.

Proposed Metrics:

1. Average time taken by end users to locate relevant data. Use of an information catalogue can reduce the time taken by users to locate relevant data from weeks to hours (Butler Cox, 1988).
2. Average time taken by developers to locate and extract source data for MIS and EIS. One of the major problems in building MIS is finding out how to access and interpret "legacy" data in existing systems (Giordano, 1993). The information catalogue can reduce time to locate data as well as providing the basis for conversion of data to a common format.
3. Estimates of time savings for both users and developers as a result of using the catalogue.
4. Percentage of existing databases/files mapped to the enterprise data model (Simsion and Drummond, 1992). This should include PC applications, software packages and applications developed by end users. This gives an indication of the level of completeness of the information catalogue, and is also a measure of the IRM group's progress in documenting the organisation's existing data.

Goal #4: Organisational Integration

Organisational integration is defined as the ability of an enterprise to coordinate operational activities and to make organisation wide responses to business problems. Porter and Miller (1985) define an organisation's value chain as a system of interdependent activities which are connected by *linkages*. Careful management of these linkages is a powerful source of competitive advantage because of the difficulty competitors have in perceiving it. According to Stalk (1988), gaining competitive advantage almost always requires integration of business activities. Improving downstream linkages with suppliers and upstream linkages with customers also provides opportunities for competitive advantage (Porter and Miller, 1985).

A prerequisite for improved organisational coordination is an enhanced ability to communicate within or among organisational units (Goodhue et al, 1988). The IRM group can assist in this by ensuring that data have the same meaning and use across time and across users. This effectively provides a common language for communicating about business events, which is essential for coordinating diverse and far-flung units of the organisation (Goodhue et al, 1992). Sharing of information between different business areas leads to improved coordination and communication across organisational functions. This increases the opportunity for synergistic cooperation to streamline business processes and cut costs in ways that increase business effectiveness (Hufford, 1993).

Proposed Metrics:

1. Information Float. This is the time delay from when one area of the organisation captures a fact of information until others in the information value chain are able to access it (English, 1993). Usually this time delay is the result of having to re-enter data into different systems or for interface programs to copy or translate the data from one system to another. At each stage in this process integrity problems may be introduced.
2. Turnaround time to customers and suppliers. This is the average time it takes for customers or suppliers to receive a response to a query or a transaction.
3. Cost impact of turnaround time ($). A method for quantifying the costs of organisational response time is to conduct a statistical survey of customers to determine the extent to which this feature might affect their decision to purchase. With this information, it is possible to project the impact on sales (Cougar, 1987).

Goal #5: Data Model Quality

As part of the process of ensuring conformance to the enterprise model, one of the roles of the IRM group is to conduct quality reviews of all project data models. Quality assurance of data models decreases development costs because the sooner an error is found and corrected the less costly it will be (Moody and Shanks, 1994). Research shows that the cost of rectifying defects post implementation is between 100 and 10,000 times as much as fixing the problem that caused them during analysis (Index Foundation, 1993).

Proposed Metrics:

1. Requirements error distribution per development phase ($): This measures the occurrence and cost of requirements errors in each phase of development. This can be monitored over time and against industry averages. Studies have shown that more than half the errors which occur during development are the result of inaccurately defined requirements (Martin, 1989).
2. Requirements change distribution per development phase ($): This measures the occurrence and impact of requirements changes in each phase of development. The cost of adding to or changing requirements increases exponentially over the development lifecycle (Brooks, 1978; Butler Cox, 1987). The number of changes required after analysis reflects how well requirements were defined to start with.
3. Estimated cost savings as a result of early detection of errors ($): This is calculated by looking at the total cost of requirements errors and changes compared to pre-IRM figures or industry averages. Research shows that defect detection during the analysis phase is up to 33 times more cost effective than testing at the end of development (Russell, 1991).
4. Cost of maintenance changes ($). The IRM group should ensure that data is organised in a way that reduces the need for future restructuring as a result of requirements changes or new and unanticipated processing requirements (Simsion and Drummond, 1992). Experience shows that the most expensive changes of all are those which require changes to the database structure, because each such change has a "ripple effect" on all the programs that use it (Simsion, 1994). Comparison of maintenance costs between systems developed with IRM involvement and without over time will show the impact of IRM practices on maintenance. Empirical studies have shown reductions of 80% in maintenance costs of systems developed in an IRM environment (Hufford, 1993).

The measures proposed here may be used to monitor improvements in development productivity over time. However these measures are even more useful for assessing the effectiveness of IRM if they are collected separately for systems developed with IRM involvement and those developed without (eg. prior to the IRM function being established). This allows the impact of IRM on development productivity to be more precisely determined by effectively providing an experimental "control group".

Goal #6: Reuse of Data

A major role of the IRM group in the development process is to identify opportunities for data reuse. Reuse is one of the most direct, powerful and quantifiable measures of IRM benefits, and represents one of the major opportunities for organisations to increase their application development productivity (Index Foundation, 1993). Empirical research shows order of magnitude increases in development productivity (up to 300%) as a result of a strategy of systematic reuse across an organisation (Banker and Kaufmann, 1991).

Proposed Metrics:

1. Reuse Percentage (%): Average percentage of data reused per project. Once there is a "critical mass" of data in the enterprise model, new projects should require minimal new development and will tend to just reuse and refine existing data and processes. Studies in practice have shown that after only two years, projects require only 25% new objects on average (Banker and Kaufmann, 1991). This translates into a reuse percentage of 75%.
2. Potential Reuse Savings ($): This can be estimated by converting the data and processes reused to function point form and then multiplying this by the average cost per function point for the organisation. In practice, the amount of effort required should be less than this as a result of the scale diseconomies inherent in systems development (Banker and Kaufman found that 1% reuse generally leads to 1.9% reduction in effort).
3. Actual Reuse Savings ($): This is the difference between the estimate of project costs based on total function points less the actual project costs. There are a number of reasons why the actual savings will differ from potential savings. One is the margin for error in all estimates of effort. The other is that the project may decide to build their own version of the common data rather than reusing it at the physical level.

Goal #7: Management of Redundancy

Redundancy refers to the duplication of the same information in different databases or files. The goal of the IRM group is to minimise redundancy of data through data sharing. A second goal is to minimise the impact of redundancy on the user by ensuring that different copies of data are synchronised. A certain amount of data redundancy is unavoidable in most organisational contexts. The enterprise model, when mapped to existing systems, provides the mechanism for keeping track of all copies of a piece of business data, and ensuring that appropriate data movement methods exist to keep copies consistent (Butler Cox, 1988).
Controlled redundancy is where the synchronisation of different copies is handled automatically by the DBMS or application programs. *Uncontrolled* redundancy is where information must be manually updated in different locations (Date, 1989). Controlled redundancy represents an overhead to the organisation in terms of storage costs and synchronisation costs. Uncontrolled redundancy represents a threat to data quality (as a result of copies of data becoming inconsistent) as well as requiring the same data to be entered separately into different systems.

Proposed Metrics:

1. Average number of copies of corporate data. This is determined by mapping objects in the enterprise data model to files and databases. This should include PC applications, software package and user developed systems (eg. Spreadsheets). It is doubtful whether many organisations know the true extent of data duplication that exists. It is likely to be much higher than anyone imagines but is rarely quantified in practice. Love (1994) reports a study carried out in one organisation where it was found that there were, on average, 25 copies of every piece of corporate data. Clearly, the cost to the organisation of storing this information and keeping it up to date would be enormous.
2. Cost of storage of redundant data ($). This can be calculated based on the total amount of redundancy multiplied by the unit cost of physical storage.
3. Cost of redundant data entry ($). This can be estimated using standard data entry costs. Multiple data entry represents an ongoing cost to business areas and a major source of irritation to users. One insurance company found that it was storing a single fact of data 43 times, and that 43 different people within the enterprise were creating and maintaining the same data independently (English, 1993). This measure applies to uncontrolled redundancy only.
4. Synchronisation costs ($). This is the cost of keeping different copies up to date in the case of controlled redundancy. This can be estimated using a standard transaction cost multipled by the update frequency (Simsion and Drummond, 1992).
5. Overall cost of redundancy ($): This is the total cost of redundancy to the organisation, calculated by adding together the three previous measures. Calculating the overall cost of redundancy to the organisation provides an excellent business case for IRM. However very few, if any IRM groups attempt to quantify the cost, despite its obvious utility as a means for their justification. It is an expensive and time consuming exercise to try to do this across all the organisation's data stores, but sampling techniques can be used to estimate the overall cost.
6. Level of inconsistency (%). This represents the variance between different copies of the same data using statistical sampling. This will depend on whether the redundancy is controlled or uncontrolled, volatility of the data, and frequency of synchronisation.

These measures should be used to assess the current cost of redundancy to the organisation and then to measure improvements to the situation as a result of IRM initiatives.

Goal #8: Systems Integration

Systems integration is defined as the ability of different systems to communicate with each other without the need for explicit translation or conversion of data. Incompatibility of data definitions between systems means that it is difficult to access or consolidate information across application boundaries. The result of this is that it is often quicker to rekey information produced by one system so that it can be used by another (Butler Cox, 1988). IRM can help to improve integration of systems by ensuring common data naming, definitions and formats across different information systems. This simplifies communication between systems and removes the need to build explicit interfaces between them.

Proposed Metrics:

1. Interface costs ($). IRM should greatly reduce costs of building interfaces between systems. Empirical research shows that these savings are of the order of 85% (Hufford, 1993). The cost of developing,

operating and maintaining these interfaces can be included in this metric (Simsion and Drummond, 1992).

2. Manual costs of consolidating data from different systems ($). In a non-integrated environment, data from different applications can only be merged and consolidated with significant manual intervention, translation and discrepancy resolution. This is a hidden cost of non-integration which is borne by business users. A division of a Fortune 500 company found that 46% of its total resources were dedicated to deriving information from data (Hufford, 1993). By standardising data definitions and formats, IRM activities can reduce this work effort required.
3. Data translation processing costs ($). Studies by IBM have shown that upwards of 70% of processing time in large systems is spent translating data formats and structures between applications (IBM, 1993). By providing common definitions of data across systems, the translation effort required should be minimised through IRM practices.
4. Cost of extracting data for MIS and EIS ($). IRM can help to simplify the collection, comparison and aggregation of data for management reporting as a result of common data definitions across operational systems. The major overhead in building MIS and EIS is in building interfaces to extract data from operational systems and convert it to a common format. It is estimated that this represents 90% of the cost of such systems (Inmon, 1992).

APPLICATION IN PRACTICE

Selection of Metrics

It is not expected that an IRM group would use all of these metrics in implementing a measurement programme. Because each IRM group has unique circumstances, finding a single, comprehensive set of measures that will suffice for the evaluation of the performance of all groups is unlikely (Green, 1989a). The metrics proposed here are intended to be used by organisations as a starting point for developing their own measures, by selecting those which are most appropriate and devising new measures if necessary.

Selection of appropriate measures to use should take place based on perceptions of the value of the measure, as well as the difficulty of obtaining the information. Many of the measures defined are dependent on particular information being collected as part of the development process (eg. number of defects, cost of defects). If such recording is not part of IS procedures, alternative measures will need to be used. A team approach is highly recommended to determine the metrics to use. Involvement of all stakeholders (application developers, users, senior management) in the definition of appropriate measures will result in better organisational understanding of the aims of the IRM group, and a cooperative approach to solving the information management problems of the organisation.

Implementing an IRM Measurement Programme

The collection of performance measures may seem like a major operational overhead to the average IRM manager, which may compete for already scarce resources that could be used to solve problems of a more immediate nature. However for the long term survival of IRM in an organisation, the question that needs to be asked is: Can you afford not to? Too often IRM groups defer establishing the necessary information collection systems until senior management requests justification for the existence of the group or funding for a particular IRM project. By the time such a request is made, it is often too late to gather the information that will prove the value of the group (Green, 1989a).

It is never too early to begin measuring results. However the task of collecting measures across the entire collection of organisational data sources is too large to tackle at once, and should be attempted in stages, based on organisational information priorities. Manageable subsets of data may be defined so that the task can be approached in an incremental manner. For example, customer data may be measured first, then product data, account data and so on. Given the value of such information for gaining and maintaining support, it is reasonable that an IRM manager devote a significant portion of his resources (eg. 10 percent) to the establishment of measurement procedures and evaluation of results (Green, 1989a).

Summary of Metrics

The table below summarises the goals and metrics proposed in this paper:

Goal	Metric(s)
Information Value	Current actual value of information ($) Potential value of information ($) Information Gap ($)
Information Quality	End user surveys Customer/Client surveys Percentage/size of errors based on statistical sampling Estimate of business cost of errors ($)
Information Accessibility	Average time taken by end users to locate relevant data Average time taken by developers to locate and extract source data Estimated time savings for end users and developers ($) Percentage of databases and files mapped against enterprise model
Organisational Integration	Information float Turnaround time to customers and suppliers Cost impact of turnaround time ($)
Data Model Quality	Requirements error distribution per development phase ($) Requirements change distribution per development phase ($) Estimated cost savings as a result of early detection of errors ($) Cost of maintenance changes ($)
Reuse of Data	Reuse percentage Potential reuse savings ($) Actual reuse savings ($)
Management of Redundancy	Average number of copies of each piece of corporate data Cost of storage of redundant data ($) Cost of redundant data entry ($) Synchronisation costs ($) Overall cost of redundancy ($) Level of inconsistency (%)
System Integration	Interface costs ($) Manual costs of consolidating data from different systems ($) Data translation processing costs ($) Cost of extracting data for MIS/EIS ($)

Figure 3. Table of IRM Goals and Metrics

CONCLUSION AND FURTHER RESEARCH

Implications for IRM Practice

Use of the metrics proposed in this paper will help IRM practitioners in a number of ways. Firstly, it will help IRM groups to justify their value to the organisation in a tangible way, and to develop and maintain ongoing management support. It will also help to ensure the success of the IRM effort through communication of the benefits rather than through prohibition or policing. It can also help the IRM group to identify those areas in the organisation where efforts may prove most useful, and provide the basis for continuously improving and adapting their strategies.

IRM measurement can also help to develop better measures of the overall effectiveness of the IT function. Current notions of IT effectiveness measurement concentrate on operational efficiency and immediate problems hampering these operations. The IRM measures defined here focus on the information itself rather than the technology, which is the key to successfully aligning IT with business strategies (Glazer, 1992).

Further Research

Research is currently in progress to empirically validate the goals and metrics defined with expert practitioners. The set of goals and metrics defined in this paper will be used as a starting point for developing a "consensus" set of IRM goals and metrics, agreed across a wide range of experts, including application developers, IRM practitioners and business users. It is also the subject of further research to extend the framework by exploring strategies which may be used to achieve IRM goals. For example, building subject databases (Martin, 1989) or reference tables (Simsion, 1994) may be used to reduce redundancy of data.

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