

Data and Information Quality

How They Affect the Value of Business Information

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► INTRODUCTION

For sometime now Butler Group has been highlighting the importance of Data Quality (DQ) in the business decision-making process and the huge part that it plays in the successful delivery of business outcomes. However, the acceptance of this fact by the business world has been slow to come. Many organisations focus their attention on DQ wholly in the customer names and address area, but DQ issues apply to all business information and an end-to-end approach is required. This is challenging as the path taken by data on its long and sometimes complex route before its transformation into Business Information is full of potential pitfalls, but the end justifies the effort. Decision-makers need information to gain insight into business and to measure progress or performance against set goals, such as those that may be expressed in Key Performance Indicators (KPIs). Poor DQ can give false impressions or confusing versions of what is going on in the business and lead to the wrong business decisions being made with potential disastrous outcomes, directly affecting the business' bottom line.

A recent Butler Group survey confirms that most companies acknowledge the role that Information Quality (IQ) plays in producing reliable Business Intelligence (BI) with 54% agreeing that DQ should be improved for planning and Management Reporting for BI, but a staggering 38% thought that their corporate DQ was poor with 47% planning to improve their DQ within the next 6 months.

Despite the good intentions of the survey's respondents, figures from the industry show that less than 1 in 20 companies have developed an Information Quality Management (IQM) strategy, that is deployed and backed up with sufficient processes to ensure that the business value of information is maximised, and that the risk of using information of low or unknown quality is reduced to the minimum. Using unreliable information to evaluate progress and performance is at the least risky, and at worst, downright dangerous.

This White Paper examines what constitutes 'good DQ' and 'good IQ', how this can be measured and improved, and how data and information quality levels directly affect the 'value' of Business Information, as presented to Managers and other knowledge-workers in the form of BI, Performance Reports, Management Dashboards, Scorecards, and similar vehicles.

► DEFINITIONS

Although DQ and IQ are discussed separately in this White Paper, it is important to note that IQ encompasses DQ as one of its essential components.

What is Data Quality?

DQ is a measure of the data from the point-of-view of the following main attributes:

- Completeness.
- Validity of format.
- Validity of data content.
- Conformation with Business Rules.
- Accuracy (insofar as this can be measured against another source known to be accurate).

DQ is measured at the individual data item level within a file or database table, and is much more than 'data cleansing', which focuses mainly on standardising and improving name and address data.

To illustrate the point, let us examine the following example of a DQ issue:

A DQ analysis of a Hospital Patient Master Data File reveals that there are 2,000,000 records containing 1,800,000 unique patients, with 200,000 records that appear to be 'near duplicates' and probably refer to one of the 1,800,000 uniquely identified patients. An analysis of the telephone number (TELNO) field reveals that only 1,700,000 records have a valid telephone number, 100,000 records contain some data in the TELNO field, but it is not in the correct telephone number format, and 200,000 records have no data in the TELNO field at all.

From these results, the Hospital could evaluate the risks associated with data from one patient being located in two or more patient records, for example; the entire medical history of one patient may not be accessible to all departments. They may decide that the Patient Master File must be reconciled to remove duplicate records. If it is considered essential that each patient's telephone number should be available, an action could be started to obtain the telephone numbers for patients where this data is missing, and to review the 100,000 telephone numbers that are in wrong format and steps can be taken to standardise them. Specialised DQ software is available to automate this process.

Data Quality Management (DQM) can be performed on all structured data.

Unstructured data (such as videos, presentations, e-mail, and other textual documents) does not lend itself to be 'quality-managed' in this way. For these data types, DQM is limited to a few perfunctory checks only.

What is Information Quality?

Here are the definitions of two leading experts in the field of IQ:

1. (a) Consistently meeting all knowledge worker and end-customer expectations in all quality characteristics of the information products and services required to accomplish the enterprise mission (internal knowledge worker) or personal objectives (end customer). (b) The degree to which information consistently meets the requirements and expectations of all knowledge workers who require it to perform their processes. (Larry English)
2. The fitness for use of information; information that meets the requirements of its authors, users, and administrators. (Martin Eppler)

IQ is measured in business terms at the knowledge-user interface, that is, the point at which the intended recipient receives the information in a form which he/she can understand it (usually a written or screen-based report). This is the point at which 'data' becomes 'information'.

Business IQ is largely influenced by the following factors:

- The quality of the data used to create the information.
- The quality of the programming used in data-manipulating processes.
- The 'relevance' of the information to the recipient.
- The completeness, clarity, and non-ambiguity of terms and definitions.
- The alignment between: What the information theoretically or officially represents ('Corporate definition'), what each knowledge worker believes it represents ('individual's perception'), and what the information factually represents ('IQ analysts findings').

► THE BUSINESS IMPERATIVE

The link between IQ and DQ, on the one hand, and the traditional business imperatives of reducing costs, increasing revenue, or improving customer service on the other, has not always been understood or appreciated. It often requires a serious or high-profile exposure to persuade management to allocate funds to improve IQ, and then it may be limited to fixing the immediate problem, rather than taking a holistic, pro-active and preventative approach. However, in the past five years, a number of high-profile cases of fraud and incompetence have changed management's attitude towards information quality. To be exact, it was not the high-profile cases which changed attitudes but the introduction of legislation to regulate how companies share or publish information, and punish the offenders.

In order to protect the public and the shareholders, there are now a whole range of legal requirements and guidelines which require companies to take more care in managing IQ, such as Sarbanes-Oxley, various European Directives, Corporate Governance, Privacy Laws, Freedom of Information Act, and Industry Watchdogs, etc. Additionally, as legacy systems are phased out and replaced by Enterprise Resource Planning (ERP) systems, and with the advent of Service Oriented Architecture, Master Data Management, process outsourcing, and similar 'new' approaches, the link between high-quality data, reliable information, and 'business value' is becoming clearer. In the wake of liberalisation and globalisation, some industries have discovered a whole new world of competitiveness, where quality of service to the customer is now the main differentiator between them and their competitors.

Whether we like it or not, our businesses are becoming more regulated, more sensitive to public and customer opinion, more competitive, and therefore more driven by performance management. In this environment, the business imperative for managing information and DQ is stronger than ever before.

Managing the Unknown

You can not manage something that is not measured, and is therefore unknown. This is most certainly true for BI and in fact, for all information in general.

In practice, BI is generally well-presented to its intended audience via colourful dashboards, charts, and other visualisation techniques, often with features such as 'Drill-Down' (to get more details), Trend Forecasting, Traffic-Lighting etc, but what is the value of good presentation if the reliability (that is: the 'value' or 'quality'), of the information is unmeasured and therefore unknown? Most of us would agree that there is not much value in unreliable information, and the only way to maintain a high level of information reliability is to 'quality-control' the information production process. Quality control is an essential part of every other industry's production process (think of a Car Factory, a Food Processing plant, House building etc.), and is performed at many points during the production process to ensure that any errors are identified as soon as possible, so that remedial action can be taken at the right place in the process, and that the finished product is 'fit for purpose'. It is also through the 'quality-control process' that many opportunities to improve operational and analytical processes are discovered.

Strangely, those in the 'Information Production Industry' have been slow to embrace the quality-control philosophy practiced in all other industries. Why is this? Is it because our 'product' (information) is less tangible than a car or a house? Perhaps it has more to do with the fact that our industry (information production) grew out of an ill-disciplined environment where too many people had access to operational data, and anybody with some programming knowledge could create a report. With the advent of cheap but powerful desktop computers and tools each department set about gathering data and processing it to create its own set of Business Intelligence (BI) reports. The focus was on creating good-looking reports rather than ensuring that they were based on reliable data. It is interesting to note that most companies have the means to gather data and convert it into a set of business reports, but few companies have implemented a 'quality-control process' to ensure that the information produced is reliable! In the absence of quality control, the information may be pointing us in entirely the wrong direction, leading us to the wrong conclusions and inappropriate actions. Furthermore, when any piece of information is found to be unreliable, it casts a shadow of doubt over all the information.

Prevent or Cure

IQM should be focused on preventing, rather than correcting quality problems. However, in practice it is usually a mixture of corrective and preventative measures, since few companies are starting from a clean sheet, and have inherited situations where existing data and information are already infected with quality issues.

Not knowing how reliable business information is, is worse than knowing that it is unreliable.

When the IQ has been measured, and its reliability level is known, information consumers can take the reliability level into account when making decisions: bolder decisions when the quality level is high and cautious decisions when the quality level is low. Any information which has not been quality controlled introduces an extra dimension of risk that should result in cautious decision making. Unfortunately, this is not usually the case as knowledge workers and managers are seldom aware of the impact of quality issues, and tend to take the information at its face value, assuming that it is of good quality.

The Business Case for Information Quality Management

It is often not the size of the actual problem which is being reported in BI, but the conclusions drawn from a report about the problem, and if this report has been compiled from data of low or unknown quality, then the facts may be 5% or 95% incorrect. Without quality control we have no way of knowing! The benefits of positive returns from a DQ initiative can be split into three main areas:

- **Data management:** Isolated (yet potentially significant) savings from improved data management, including streamlined and efficient transformation processes geared by real business drivers and increasing the opportunity for risk management.
- **Reduced operational costs:** Reducing errors and elimination of duplicated effort, reduces costs and wastage and improves customer service.
- **More effective decision-making:** The benefits of improved decision-making can be significant and long-term in nature. It is not just a question of improving those micro decisions made on a day-to-day basis, building a bedrock of properly managed, quality data improves the process of strategy formulation and execution, resulting in a better competitive edge.

These ideas are brought together in the following diagram:

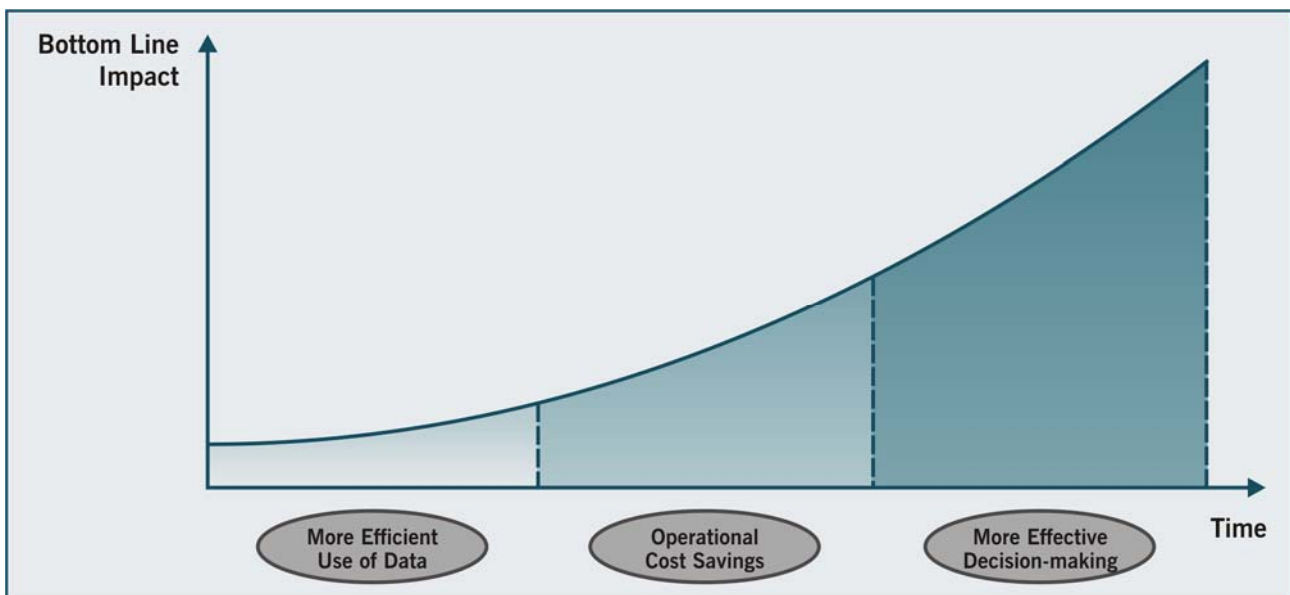


Figure 1: Cumulative ROI from Data Quality

Here is a general guideline to building the business case:

- Explain the risks and estimate the costs of using non-quality-managed business information (as set out in other sections of this White Paper).
- Explain that a relatively modest investment now will improve the speed, reliability, and accuracy of performance analysis, problem solving and decision making in the future.
- Identify all areas which would benefit and provide estimates of potential resource savings (money, time, and man-hours).
- Estimate the 'intangible benefits' – better BI equals more confidence amongst users and 'higher-added value' to Performance Management and other issues requiring business information, leading to more efficiency, better internal and external reputation (improved image), and a higher level of customer satisfaction.
- Use examples of recent 'problem situations' relevant to your company, where analysis based on internal information played a role; recent performance issues, uncertainty or distrust of information, external exposure (client dissatisfaction), Regulation requirements, etc.
- Commission a short Data/Information Quality Scan to demonstrate the potential for improvement, based on objective measurements.

Only business cases which demonstrate a positive Return On Investment (ROI) have a chance of success. Equally important is to obtain the support of a senior manager who understands the risks associated with unreliable business information, and who will therefore be able to explain the issues to any doubters among his/her fellow managers, and ultimately obtain their approval for an IQM initiative.

► TACKLING THE PROBLEM

One of the underlying issues with regards to DQ relates to the profile that it has in the business. It is seen as a departmental, or even worse, a user issue, often treated as an individual or isolated problem. DQ problems cannot be addressed on a case-by-case basis. Data quality has to be seen as a proactive, business-oriented strategy, not a reactive discipline of hopping from problem to problem. Put in a slightly different way, organisations need to examine the processes by which data is created, transformed, and used, not just considering its final form. It is only by adopting this process view that the business can hope to gain full control over its data, helping to deliver accurate and reliable information to users, customers, partners, and other important stakeholders, and develop streamlined optimised processes that eliminate unnecessary wastage.

It is therefore essential that organisations undertake a DQ strategy to shift the culture of the organisation from one that is generally uninformed and oblivious to the impact of DQ, to one that recognises it as the cornerstone of balanced business.

The Strategy

A DQ strategy clearly needs to address key issues – cultural and technology aspects of DQ and integrity. It has to have top-level sponsorship and be driven by the board. It has to be flexible to accommodate changing business needs. The strategy needs to be comprehensive and applied consistently across the business.

The key is to start small, demonstrate deliverable business benefit before extending via subsequent iterations. This does not mean that the business has to do everything at once – DQ strategies need to follow a phased implementation in order to break investment down into manageable chunks and ensure that things progress as planned. For example, in the past often accepted practice saw the construction of a large data warehouse before any attempt was made to extract its latent value through front-end tools and applications.

Thankfully, this fundamentally flawed approach is being phased out and replaced with lightweight, iterative deployment methodologies. By starting small, organisations can see deliverable business benefit, before extending via subsequent iterations. Ideally, each iteration should try to generate the investment for the subsequent one, safeguarding the organisation from a financial and risk exposure perspective.

In short, a DQ strategy has to balance technology and culture, security with accessibility, and proactive measures with reactive disciplines.

Who is responsible for Data and Information Quality?

Traditionally, the responsibility for DQ has been allocated to the IT department. After all, they are the people who look after the databases where the source data resides; they are the people who create and manage data warehouses and data marts; they are the people who are responsible for archiving, controlling access to and generally managing data, and they are the people who have the detailed technical knowledge required for manipulating data via programming, and for creating queries.

But is the IT department the place where a data management strategy should be defined? Does the IT department understand the relationship between data items and business entities? Is the IT department aware of the business consequences which can result from low-quality data?

In our view, the responsibility for IQ (which includes DQ), should lie with the business 'owners' of the information (or data). It is the business users who understand the context of the information. It is the business departments who have the most to gain or to lose by the level of IQ. The strategy and the tactics of IQM should therefore be decided by the appropriate users of the business information. The IT department is the place where the strategy and tactics are implemented at a technical level.

Organisations may wish to consider using the RASCI model when deciding who is involved in managing quality. This is outlined in Table 1:

| | |
|-----------------|--|
| R – Responsible | Owner of the subject matter |
| A – Accountable | The person to whom 'R' is accountable, the person who must 'approve' the work |
| S – Supportive | Someone who can provide resources or play a supportive role in implementation |
| C – Consulted | Someone who has to be consulted as he/she has information or capability needed |
| I – Informed | Someone who has to be notified of results, but does not need to be consulted. |

Table 1: The RASCI Model

In a holistic approach with the focus on IQ (of which DQ is an important sub-component), overall responsibility is placed in the business area where the need for the information is strongest; Financial Department for Financial information, Marketing Department for Marketing information, HR Department for employee information, etc.. Once the high-level responsibilities for information have been decided, the question of individual responsibility for individual information and data items can be more easily addressed. The key is that every unique data item or Business Rule or Definition has a specific 'owner', otherwise no-one will feel responsible, or several people may feel responsible and may not necessarily work as a team. The worst situation, and unfortunately, still the most prevalent, is when it is unclear who is responsible for each item. In this scenario, everyone agrees that "DQ is a problem", but no-one feels that it is his/her task to do something about it, and so the quality level deteriorates even further.

Recognising the Symptoms of an Information Quality Problem

Here are some typical indicators of when there is an IQ problem:

- Different people supply different answers to the same question.
- It is sometimes difficult to compare or merge information from different sources.
- When there is no single company-wide reference set explaining the meaning of all the terms and definitions used.
- If the documentation describing operational processes is not up to date.
- Sometimes mistakes are spotted externally by customers and partners; when they receive an incorrect communication or incomplete information.
- When too many resources in terms of money, time and effort, are allocated to investigating and correcting faults and inconsistencies.
- When a company does not know how good or bad the quality of its data/information is because it is not objectively measuring it.
- When a company can not analyse the quality of its operational processes, because the quality of its information is not known,
- If the staff of a company suspect that the information produced in-house is unreliable, but they have no way of proving it.
- Some departments create and use information from data that they have collected themselves.
- When consistent standards are not applied to the format and quality of data/information.

Measuring Data Quality

Managing DQ is a cyclic activity which can be largely automated. The first step is to decide on the scope of data to be managed. In the holistic approach to IQM, the scope of data items to be managed will be decided by their relevance to KPI's. Data which is needed to calculate strategic KPI's will be top of the list, followed by additional data items needed to calculate tactical or departmental KPI's.

Measure

Once the scope of data items has been defined, a measurement can take place to quantify:

- Completeness – identify records with no data for the data item being measured.
- Validity of format – identify records with data in an invalid format.
- Validity of data content – identify records with a data value which is not valid, according to a set of data content validity rules.
- Conformance with Business Rules – several record types or data sources can be compared with each other to test that the data is compliant with a set of pre-defined Business Rules.
- Accuracy – compare data with a limited set of Reference data whose accuracy is guaranteed.

These measurements can be repeated for each data item to be measured. The results of each of these measurements can be expressed as follows:

- Number of records examined.
- Number and percentage of records which are OK.
- Number and percentage of records which are not OK.

Evaluate

In some cases, an evaluation of the results may reveal that the data measured is in fact 'OK', but that a Business Rule, or the definition of what constitutes a valid value ('Reference Data'), was incorrect.

In this situation the Business Rule or Reference Data should be corrected and the measurement repeated.

Investigate

To facilitate further investigation and, if appropriate, correction of quality issues, a means of identifying the individual records flagged as 'NOT OK' (per data item measured) should be available. The results of the measurements should be discussed with data owners and IT to try to establish the cause or reason for each condition reported as 'NOT OK' and to prioritise any improvement actions.

Implement Actions

In many cases a large number of records may all have the same 'symptom' of low quality, and a single corrective or preferably preventative action, may be possible to improve the quality of all these records. Clearly a preventative action is better because it will eliminate the cause of the problem permanently; whereas a corrective action only repairs the data that is currently available (tomorrow's new data may still be incorrect).

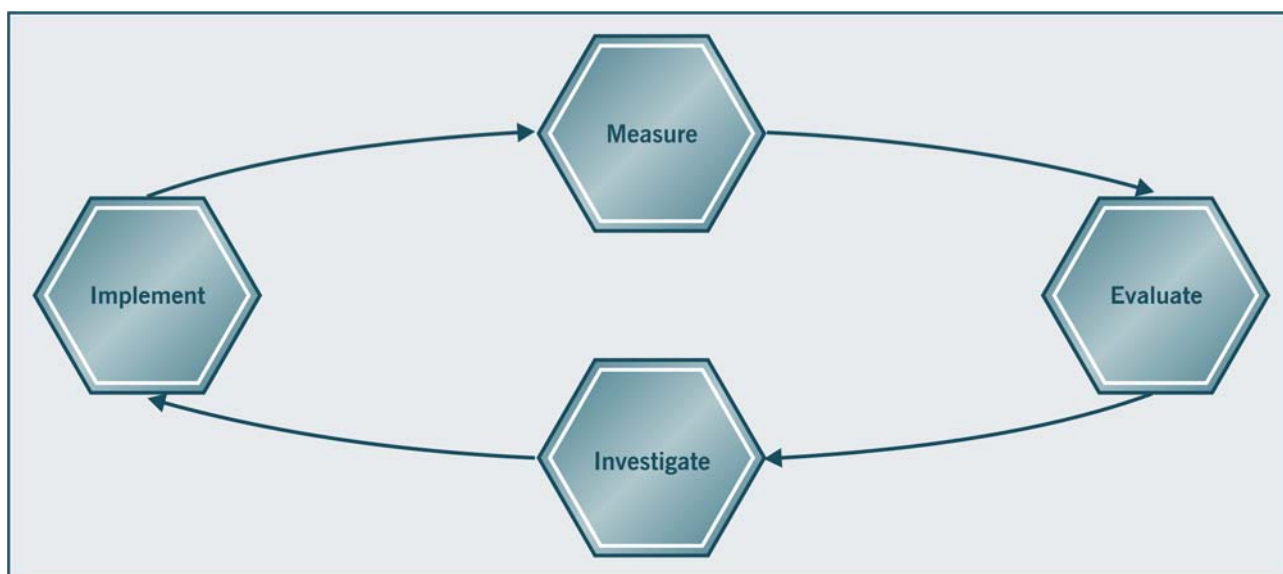


Figure 2: Data Quality Lifecycle

Re-Measure

Periodically, it is advisable to re-measure the same data items to confirm that the quality level is improving.

In the holistic approach to IQM, it is important to show the link between the quality level of data items and the effect it has on business entities measured in KPIs.

This is demonstrated in the following chart taken from a financial institution. It shows how a quality improvement programme has resulted in better quality of customer address data in the 8 months from November to June inclusive, and how this DQ improvement has resulted in a corresponding improvement (decrease) in the number of Incomplete Credit Applications (an important KPI for this Bank).

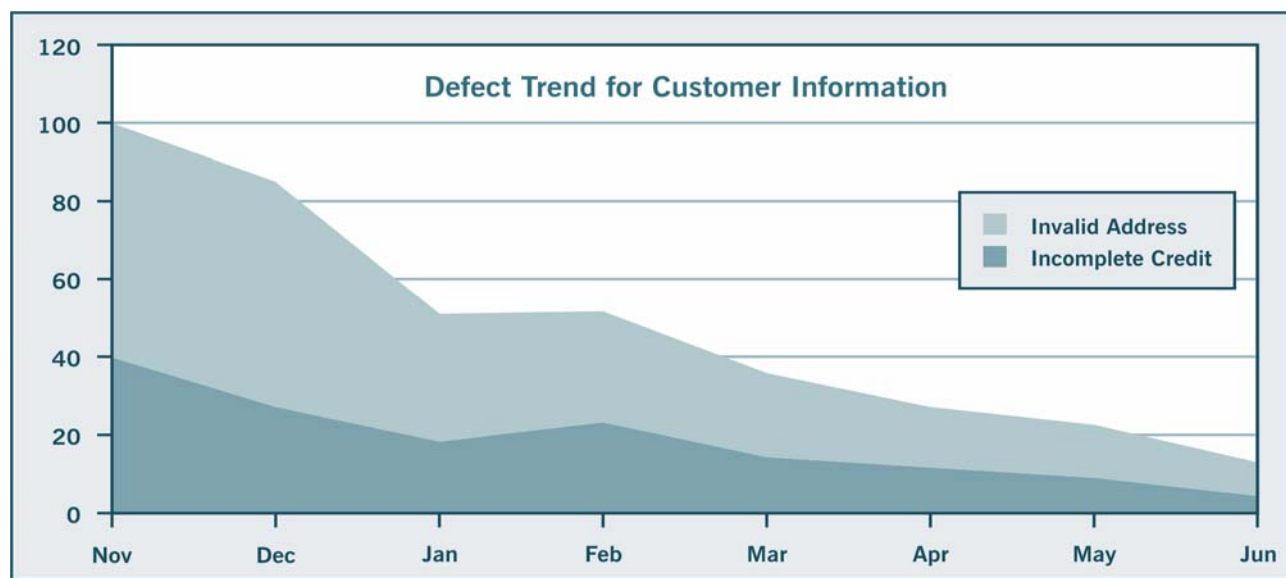


Figure 3: The Correlation Between DQ Improvement and Business Benefit

Measuring Information Quality

IQ is determined in the main by the following factors:

- The quality of the data used to create the information.
- The quality of the programming used in data-manipulating processes.
- The 'relevance' of the information to the recipient.
- The completeness, clarity, and non-ambiguity of terms and definitions.
- The alignment between:
 - What the information theoretically or officially represents (corporate definition).
 - What each knowledge worker believes it represents (individual's perception).
 - What the information factually represents (IQ analysts' findings).

Each of these factors can be measured and quality controlled. The process of measuring and improving DQ has already been addressed in this White Paper.

Quality of Programming

Business information is rarely produced directly from the operational data sources. The preferred path is to extract the necessary data from the various operational data sources into a common place where it can be standardised, quality controlled, and prepared for transformation into business information to provide insight into the state of the business, and to facilitate 'what-if' analysis, trend analysis, and performance measurement. From this common place (referred to as an Operational Data Store (ODS) or as a Data Warehouse staging area), data from different sources are linked together and the necessary calculations performed to create the aggregated and summarised entities more relevant to knowledge-workers, which are then typically stored in a data warehouse.

The quality of the transformation logic (programming) used in this process can be evaluated:

- Is the transformation logic correct?
- Has the logic been correctly programmed?
- Has the right data been obtained from the right place?

Information Relevance to Recipient

The data and the transformation logic may be of high quality but if the information delivered is not relevant, meaningful, or appropriate to the recipient, then the value of the information will be very low. Each information consumer should be able to define the information required to help them manage their responsibilities. For example, is the information provided:

- Timely?
- At the right level of detail?
- Relevant?
- Clear?

These facets should be reviewed periodically, since responsibilities and KPIs may change over time, as may the type and source of data available.

Clarity of Terms and Definitions

A lot of confusion can be caused by the 'Homonym/Synonym' problem: that is, where different entities are referred to by the same name, or when the same entity is referred to by two or more different names.

We may all 'think' that we understand what each of the various business entities we use means, and herein lies the danger. Only when terms and definitions (and Business Rules) have been clearly and unambiguously articulated in written form do we have a reference point with which we can compare our individual perceptions. Every company should therefore strive to keep an 'official set' of written definitions for each business entity for which business information is produced. Clearly, there should be only one set of consistent definitions with a company or organisation, not one set per department, and these definitions should be updated in a controlled way, taking care that everyone is made aware of the change.

Alignment of Perceptions

The alignment between the official definition, the individual perception, and a factual measurement of what an item of business information represents, is a major factor in delivering high-value 'actionable information':

- We live and work in a dynamic environment.
- New colleagues arrive; experienced colleagues depart or move to other responsibility areas.
- Departmental and individual responsibilities get modified.
- New data sources arrive, old data sources disappear.
- The business model may change.

All of these events may change the alignment of perceptions and therefore it is important to check from time-to-time, that the official definitions are still valid, and that our own individual perceptions are still valid.

If we do not do this, we are exposed to a further element of risk in the decision-making process, as well as incurring additional costs and frustration caused by different people interpreting the same thing in different ways and taking inappropriate actions. An IQ Analyst can uncover risks associated with differing perceptions and recommend appropriate action.

To maximise the value of business information, it is necessary to take a holistic approach to IQM, starting at the definition of information requirements and ending with 'Actionable Information' with the decision-maker.

Including IQ and DQ in Everyday Business Processes

Quality control is not a department; it is a frame of mind.

Quality Management is not a process which should be performed only when things get so bad that management insists we do something about it. It is a discipline which should be appended to each individual task or operation to achieve 'Kaizen' (Japanese for 'continuous improvement').

Every company should have a strategy and a process for managing IQ, not just once per year but continuously, or at least monthly.

It is essential that senior management is seen to be very involved in sponsoring and monitoring this process, which should be a monthly topic at senior manager meetings. It is advisable to appoint an Information Quality Officer (IQO) to co-ordinate the quality management effort and to report status and get management support for any further action. The IQO should come from one of the main data-owning departments and not from the IT department.

The IQM process should define which KPIs or data items are to be measured at what periodicity – daily/weekly/monthly? The measurement process should be automated and scheduled to run at a period of low activity, for example, during the weekend. The quality reports should be distributed to the appropriate business users and any unusual observations or undesired or unexplained quality issues should be discussed. An action plan should then be created to investigate any quality issues and implement improvements, either corrective (short term) or preventative (long term). This process should involve representatives from IT and various business departments. The results of a Quality Management system should be available to all.

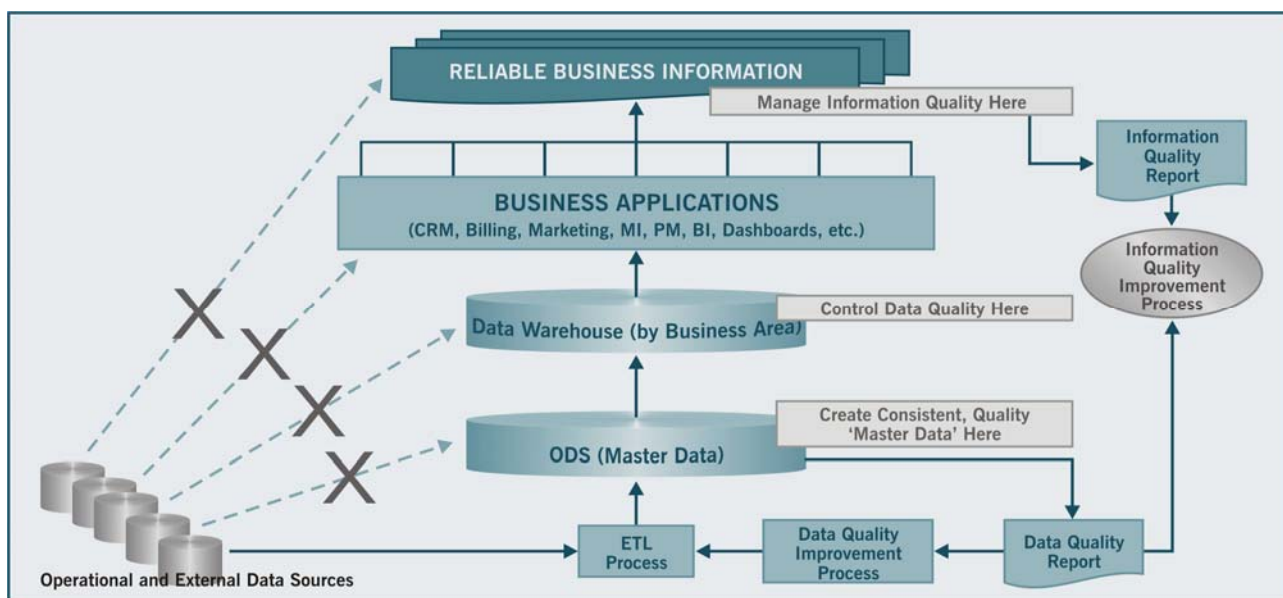


Figure 4: Integrating IQM and DQM

The Role of Technology

Technology needs to be used in a supporting role to help the business achieve its goals. One of the most common mistakes we see being made is that by investing in, say, data cleansing software, the business feels that it is then delivering data quality. Without a well-considered and robust strategy the business will never be able to plug all the holes and ensure that rules and policies are applied consistently. A DQ chain can only ever be as strong as its weakest link – put another way, it only needs for one aspect to be overlooked to undermine the rest of the investment and effort.

The Role of Information Quality in Creating ‘Actionable Information’

IQM is at the heart of turning enterprise data into actionable information. By doing this it ensures that information is:

- Relevant to a goal, for example, as expressed and measured in a number of KPIs.
- It must be trustable in terms of its validity and completeness.
- Its meaning must be clear and applied consistently throughout the organisation.
- Timely, available when needed.

Actionable information is suitable for presentation to the business decision-making process, for example, in a sales support solution, information on relevant up-sell or cross-sell opportunities might be presented to a call-centre agent during the course of interacting with a customer.

► SUMMARY

It is clear that making decisions or taking action based on information which is not trustable (not reliable), is very risky, and that information which has not been quality managed is inherently unreliable.

It is preferable to have measured the IQ level and found it to be low, than not to have measured the quality level at all! At least then the information recipient is aware of the quality level and can adjust their decision making appropriately.

There are valid methodologies and products available to measure DQ and IQ, but a company needs to overcome internal apathy before it can reap the benefits.

Every knowledge worker should be aware of IQ issues, especially those which relate directly to aligning the individual perspectives (assumptions and interpretations) to the corporate (or 'official') definitions.

Through appreciating the many IQ/DQ issues and implementing an IQM strategy, a company can add considerable value to the information it produces – BI, Performance Management, and all other forms of 'Actionable Information'.

Information is the lifeblood of a host of processes, whether these take place in a commercial business environment or as part of a public sector organisation's delivery of services through to the end-user citizen. Good DQ underlines the information that is used in these processes and is therefore of critical importance to a range of business and IT projects. We firmly believe that investing in DQ can deliver a significant positive ROI, making organisations more effective with regards to decision-making and analysis, and dramatically reducing the costs associated with remedial activities.

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