DOCTOR OF BUSINESS ADMINISTRATION

NOTTINGHAM TRENT UNIVERSITY

Sustaining Data Quality-
Lessons from the Field

Creating and Sustaining Data Quality within diverse Enterprise Resource Planning and Information Systems

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This dissertation is the final thesis of a Doctor of Business Administration programme which comprises in total six documents. The thesis is a stand alone text and is the culmination of this entire research. Reference is made to the prior documents to highlight how the early research has developed and progressed.

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List of Abbreviations

BPR	Business Process Reengineering
DAMA	The Data Management Association
DBA	Doctor of Business Administration
DMAIC	Define, Measure, Analyse, Improve and Control
DMBOK	Data Management Book of Knowledge
DWP	Department for Work and Pensions
ERP	Enterprise Resource Planning
GDP	Gross Domestic Product
GRC	Governance, Risk and Compliance
IS	Information Systems
KPI	Key Performance Indicator
NTU	Nottingham Trent University
PC	Personal Computer
PDCA	Plan, Do, Check, Act
POP	Purchase Order Processing
R&D	Research and Development
SOP	Sales Order Processing
TBA	To Be Agreed
TQM	Total Quality Management
UK	United Kingdom

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ABSTRACT

This research has identified a gap in the literature surrounding the process of improving and sustaining the quality of data within enterprise resource planning and information (ERP) systems. The study not only established firmly that quality data is an absolute necessity for all organisations, none more so than those operating ERP systems, but identified that for any improvement process to be worthwhile it must gain some degree of sustainability. For this reason this study has attempted to discover the means by which the quality of data can be improved but more fundamentally become embedded within an organisation. A detailed review of the literature was undertaken which unearthed rich material in particular around the concept of data quality and its application within business systems, from which a correlation was established between the concepts of a planning and information system and that of a product manufacturing system. A conceptual framework was then developed based upon three conceptual elements seen to be key to any data quality programme namely: *people, processes and data.*

A qualitative study was undertaken within the researcher's own organisation Remploy, employing an action research/focus group approach aligned to a data quality improvement initiative that was already in place within the organisation. A series of site meetings and conference calls took place embracing forty eight of the fifty four factories together with seven business groups. A quantitative survey was then undertaken using a web-based self-administered questionnaire distributed to a number of the researcher's colleagues within Remploy. The findings from both the qualitative study and the quantitative survey provided unique material in terms of key findings and themes. A number of principle findings then emerged relating to: the significance of the role of a 'champion' at various levels within a project; the importance of measurement, reporting and feedback relating to any improvement process; the necessity for systems and the people that use them to be allowed to mature; and the manner in which peoples' perceptions and attitudes toward data and data quality can have considerable degrees of inconsistency.

In conclusion it is felt that the outcomes of this study have the potential to both improve and sustain quality data within enterprise systems when applied to practical business and professional settings, whilst also providing the academic community with the promise of a contribution to the body of knowledge

1. INTRODUCTION AND OBJECTIVES

Introduction

There has been extensive interest in the nature of knowledge within the literature, largely related to the growth of the knowledge economy (Davenport and Prusak 1997; Davenport, De Long and Beers 1998; Hislop 2005; Orna 2005; Mutch 2008). The focus of a great deal of this investigation into knowledge management and the learning organisation has been related mainly to tacit forms of knowing Lave and Wenger (1991); Nonaka and Takeuchi (1995); Wenger (1997) and within this arena of the research, the question of *data* has tended to be rather overlooked. Other forms of enquiry however have attempted to address this issue particularly within the context of management planning and information systems (Davenport 1998; Davenport, Harris, De Long and Jacobson 2001a; Galliers and Newall 2001; Davenport and Harris 2002; Newall, Huang, Galliers and Pan 2002; Davenport, Harris and Cantrell 2004). From this research a realisation has grown that organisations that are able to collect, analyse and act on data in a strategic manner, are in a position to gain a competitive advantage within their industries, leading in some cases to domination in these areas (Davenport 2006a). This form of information management known as 'analytics' stresses that successful organisations are those that take action from their information to inform their strategic decision making Davenport (1998); Davenport, Harris, De Long and Jacobson (2001); Davenport (2006a); Davenport and Harris (2007) Davenport (2009), establishing along the way a 'fact-based culture' (Harris 2005a; Harris 2005b; Harris 2007). If this ever expanding focus on 'intelligent' business intelligence and management information is so crucial to organisational strategy, then the requirement to have quality data becomes even more paramount in manufacturing planning Gustavsson and Wanstrom (2009: 326) as well as information systems (Davenport, Harris and Cantrell 2004: 23; Stenmark 2004: 1; Economist Intelligence Unit 2006: 2, 16; Foley and Helfert 2010: 477; Davenport, Harris and Morison 2010: 1).

Extensive literature has identified the high costs of low quality data and the cost of poor data quality (COPDQ) (Redman 1995; English 1998; Redman 1998; Loshin 2001; Redman 2002; Redman 2004; English 2009). Redman (2001: Table 8.1) identified that firms may lose upwards of 10% of revenues due to poor operational data, together with other serious consequential effects relating to tactical decision making and strategy generation. A report from The Data Warehouse Institute estimated that data quality problems costs US business $600 billion a year (5% of the American GDP) in postage, printing and staff overhead costs alone, whilst the majority of the senior managers in those companies affected remained unaware (Eckerson 2002: 3). Findings from the PricewaterhouseCoopers Global Management Survey, published at the end of 2004, identified that 75% of those surveyed reported major problems resulting from faulty data, half reported incurring additional costs resulting from the need to carry out extra internal control work, whilst a third had been forced to delay new system implementations (Informatica 2005: 2). There were also predictions that

during 2006/2007 more than half the data warehouse projects would have only limited success at best (Informatica 2005). A report published jointly by Dun and Bradstreet and the Richard Ivey School of Business (2006: 1) forecasted that critical data within at least 25% of the Fortune 1000 companies would continue to be inaccurate and that "every business function will have direct costs associated with poor data quality" (Dun and Bradstreet and the Richard Ivey School of Business 2006: 2). A survey conducted by the Economist Intelligence Unit on behalf of SAP and Intel reported that 72% of the survey respondents said their data was sometimes inconsistent across departments Economist Intelligence Unit (2006: 9) and that workers frequently made poor decisions because of inadequate data (Economist Intelligence Unit 2006: 21). More recently English (2009: 4-15) outlined a catalogue of corporate disasters emanating from poor quality business information amounting to 'One and a Quarter Trillion Dollars' (English 2009: 15). During 2009 a survey of 193 organisations sponsored by Pitney Bowes, 39% of which had revenues in excess of US $1 billion, reported that a third of the respondents rated their data quality as poor at best, whilst only 4% reported it as excellent (Information Difference 2009: 4). A further survey found that less than one third of organisations regularly monitor data quality (Hayter 2010: 22). A Gartner report stated that "Through 2011, 75% of organisations will experience significantly reduced revenue growth potential and increased costs due to the failure to introduce data quality assurance" (Fisher 2009: 6). Conversely an Accenture study suggested that companies who are able to gain a better understanding of their customers, may be in a position to enhance their operating margins by up to six percent (Davenport and Harris 2002: 30).

The Focus of this Research

All the research carried out within this study, together with one's personal and professional experiences, substantiates the premise that data quality is of paramount importance to the efficiency and effectiveness of any organisation, none more so than those operating enterprise resource planning and information systems. For this reason this study will attempt to discover the means by which the quality of data can be improved, but more fundamentally, become embedded within an organisation. Without the latter, any gains emanating from the former will be merely marginal or short term at best.

Data encompasses all organisations and enterprises, together with all aspects of everyday life and therefore its quality has serious implications for everyone. Document One identified and developed the concept of data quality per se and then proceeded to place this within the context of an enterprise resource planning and information system encompassing a multi-business/multi-site operation, employing disabled people. Within Document Two a conceptual framework was developed from a comprehensive review of the literature, combined with one's own experiences. A correlation was also identified between the concepts of a planning and information system and that of a real life product or service manufacturing system both

comprising inputs, processes and outputs. Document Three expanded upon these concepts by examining further the quality management principles of initial error prevention, the identification and elimination of the root causes of data defects, combined with data cleansing and housekeeping processes. Research was carried out at a number of sites within the researcher's own organisation Remploy employing the use of focus groups in conjunction with an action research approach utilising process mapping, to study the manner in which data interacted with business processes to provide information to assist in detecting data and process problems and in identifying the ultimate ownership and responsibility. Document Four attempted to test the validity of these concepts by way of a self-administered questionnaire distributed to over four hundred data quality professionals across the world. Whilst the number of responses (29: 7%), was below initial expectations, there was reason to believe that the overall response rate was no worse than similar surveys carried out within this field. A summary of the findings indicated a high level of positive replies (76%-96%) in support of these concepts and whilst one has to balance this against the low response level, it was felt that the findings 'indicated' that there was substance to their overall validity.

Data Quality Defined

The definition of *Data Quality* employed within this research, was developed during Document Two from an extensive review of the literature as; "Having the right and correct data in the right format, in the right place, at the right time, by having one single version of the truth across the enterprise"- being an amalgam of (Redman 2004: 2; Redman 2005: 1; Griffin 2005: 2; Deloitte: 2006: 1; Williams and Beyer 2006: 2). A fundamental element of the survey conducted during Document Four, was the attempt to validate this definition. Of the seventeen specific responses, twelve (71%) were supportive whilst the remaining five provided alternative or additional definitions. This definition was also tested again within the survey conducted for this document- Section 15 Page 100. Of the twenty responses, fifteen (75%) were in agreement whilst the remaining five sought to add remarks and observations on accuracy and quality. There were no negative comments received. As in Document Four the replies were essentially positive and supportive. The placing of this definition within the overall context of data and the management of data is also discussed later within this document. It must be stressed that within this research the term 'data quality' as defined above, applies generically to both the quality of data and the quality of information. The concepts of data and information together with knowledge will also be discussed in detail in later sections.

Enterprise Resource Planning

Having established the objective of this research, as the attempt to determine the means by which quality data can be created and sustained within a diverse enterprise resource planning and information system, it is essential that an overview of enterprise resource planning as an entity be framed.

"An enterprise resource planning (ERP) system is a packaged business software system that allows an organisation to automate and integrate the majority of its business processes, share common data and practices across the entire enterprise and produce and access information in a real-time environment" (Deloitte 1999: 2). Figure 1 below highlights the integrated nature of an ERP structure or an 'enterprise system' Davenport (1998: 124), a model which is basically a series of generic business solutions which attempt to reflect how businesses potentially operate Davenport (1998: 125), seen by some as a political programme for organising change (Pollock and Williams 2008: 95).

ANATOMY OF AN ENTERPRISE SYSTEM

At the heart of an enterprise system is a central database that draws data from and feeds data into a series of applications supporting diverse company functions. Using a single database dramatically streamlines the flow of information throughout a business
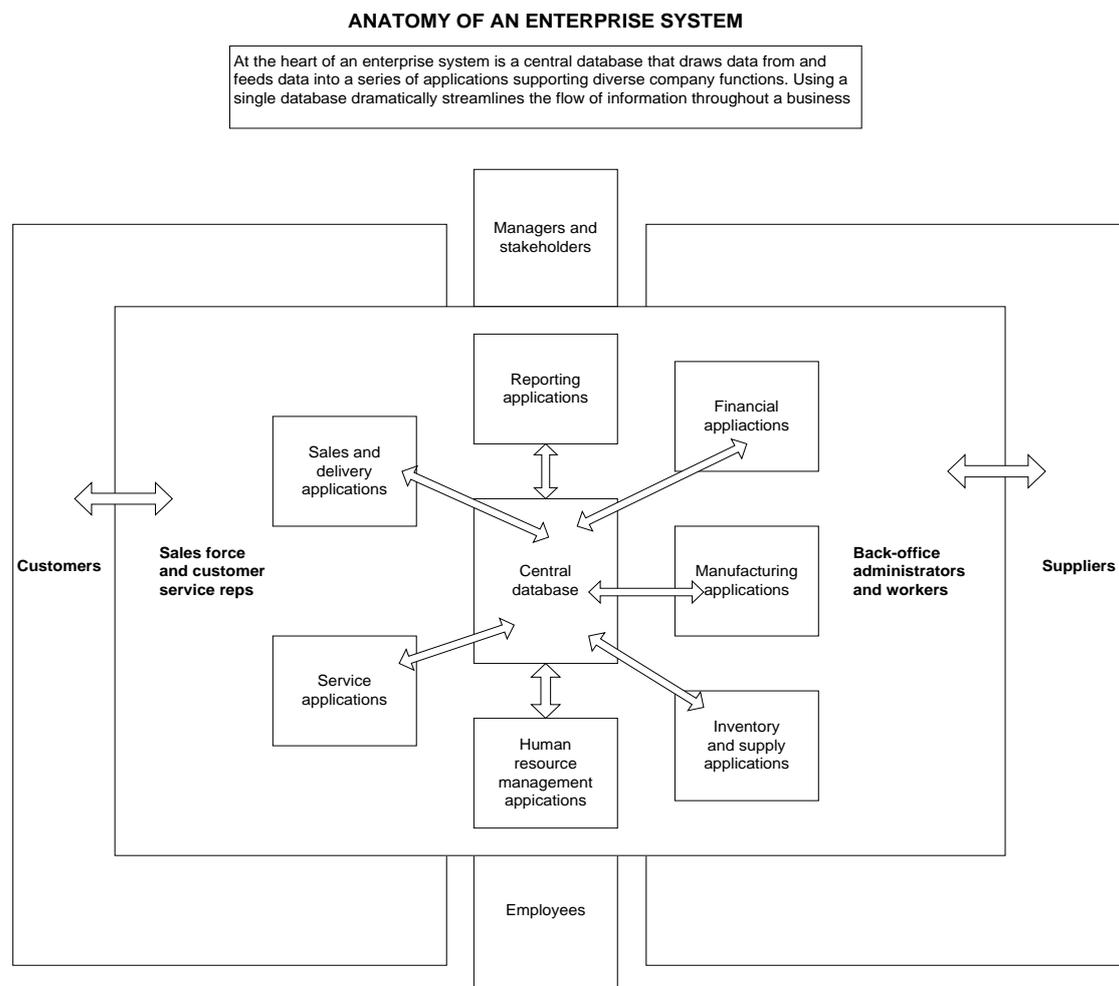
Figure 1. The anatomy of an enterprise system

Davenport (1998: 124)

Davenport (1998: 123) claimed that a good enterprise system can act as a technological tour de force with a single database at its core, coordinating and supporting virtually all of a company's business activities, but warned that if a company's systems are fragmented, its business will be fragmented also. Diverse or 'multi-site' ERP systems can be complex applications operating across multiple locations, incorporating strategic business structures, intricate software configurations, working on multiple technical platforms all of which provide organisations with serious management challenges Markus, Tanis and Fenema (2000: 43-46), requiring strong executive management and decision making (Mann 2003: 32-33).

Enterprise resource planning as a subject figures prominently within the literature; in generic terms, Klaus, Rosemann and Gable (2000); Al-Mashari (2003); Shehab, Sharp, Supramaniam and Spedding (2004); Botta-Genoulaz, Millet and Grabot (2005); Jacobs and Weston (2006); within implementation strategy and issues, Ross (1999); Markus, Tanis and Fenema (2000); Al-Mashari, Al-Mudimigh and Zairi (2002); Ho, Wu and Tai (2002); and post implementation improvements, (LaMonica 1999; Wallace and Kremzar 2001; Willis and Willis-Brown 2002; Nicolaou 2004; Outten 2005). However within this context, any in-depth focus upon the quality of the data appears to be rare (Vosberg and Kumar 2001; Wallace and Kremzar 2001; Willis and Willis-Brown 2002; Nelson 2002; Xu, Nord, Brown and Nord 2002; Davenport, Harris and Cantrell 2004: 23; Gustavsson and Wanstrom 2009: 325).This extreme bias within the literature towards initial-phase related ERP research is perhaps best illustrated by Pollock and Williams (2008:84) and Williams and Pollock (2009:3) who highlighted the fact that over ninety five per cent of the six hundred plus articles contained in *the ERP Research Group* online bibliography may broadly be described as ERP implementation studies. Such has been the fixation with 'early stage' ERP, that most of the research has focussed mainly on single site operations Williams and Pollock (2009: 2), of a short term impact, snap shot type studies of fleeting durations which lack real maturity and as a consequence may have severe limitations (Pollock and Williams 2008:84 and Williams and Pollock 2009:3). Even the literature which embraces enterprise resource planning within the themes of total quality management (TQM) and business process reengineering (BPR), which will be discussed in detail later within this study, neglected to emphasis the importance of data quality (Akkermans and van Helden 2002; Schniederjans and Kim 2003; Laframboise and Reyes 2005). One has to question whether this is a serious omission on behalf of the authors of the articles who continually fail to identify the significance of data quality within an ERP/TQM concept, or the failure of the data quality fraternity to get its message across to ERP and TQM researchers. Galliers and Newell (2001: 613) did suggest a refocusing on the management of data within ERP systems rather than concentrating on knowledge per se, especially within diverse and dispersed organisations, but omitted to make any direct reference to data quality.

The complex nature of the 'Davenport model' illustrated above with its integrated modular processes and activities, attempts to serve all the departments within an enterprise from a

single database, providing a single version of the truth throughout the entire organisation by means of a unified system; a form of processual behemoth. The model illustrates how the functions of the organisation are interrelated whereby the effect of a single transaction has a knock-on effect within or between departments of the enterprise. An ERP system operates horizontally across an organisation working within and between functions, departments and businesses, whilst in contrast most organisations manage and control vertically. This potential management misalignment may cause control problems if not recognised and eliminated, as data and information move from one department or function to another. Consequently there has to be ownership of this data or information that is passed or forwarded onwards. Organisations must recognise this potential incongruity and manage the data and information to match the required processes and data flows. This should be viewed as a supplier/customer relationship with the same responsibilities towards customer relations and satisfaction as exists or should exist in external commercial relationships. The model can become even more complex where the ERP system encompasses more than one organisation, crossing numerous countries with differing currencies, languages and time zones. Managing such complex data flows and processes is paramount. It is essential that these issues are addressed at the optimum level highlighting the absolute necessity for having some form of Data Governance policy.

Whilst the 'ERP model' is expanding further and further into multifarious organisational types, the heart of most enterprise systems are commercial transactions involving the supply of goods or services, encompassing sales, purchasing, manufacturing and distribution, all of which have financial implications. A customer order for a manufactured product will progress from an initial enquiry to final completion and payment, as the physical processes of order satisfaction, inter-act with the data flows and processes within the ERP environment. In many ways the 'system' drives the physical processes, indicating what, when and how, to purchase, manufacture, supply and distribute products to enable customers' requirements to be satisfied, in addition to recording all of the financial transactions and results. An aspect of the research carried out for this project has been the attempt to identify the impact that these elements have upon the quality of the overall data. It is intended that this model will apply equally to the provision of goods and services in both commercial and not-for-profit organisations.

Remploy

A considerable portion of the detailed research undertaken as part of this entire study has been carried out within the researcher's own organisation, Remploy. Whilst the fundamental aim of this entire research is to add to and develop the pool of knowledge within professional and management practice, it will be useful to place the company within this overall context.

Remploy is the largest provider of employment opportunities for disabled persons in the UK, currently employing over three thousand disabled people in over sixty individual factories and offices across the entire country, whilst placing over 10,000 others into external open employment, a figure which may expand by up to a factor of seven over the next five years. A Baan/Infor ERP system was implemented over ten years ago and whilst there have been many benefits overall there is still considerable scope for further improvements especially within the areas of data quality and system complexity. Maintaining sustainable quality data within any ERP system can be problematical at best, but when one factors in an organisation with twelve individual business streams operating within such diverse areas as automotive, electronics, packaging, PC recycling, healthcare, furniture, in addition to manufacturing protective clothing against nuclear, chemical and biological threats for the UK military and police, the overall picture can become very complex with a high potential for errors and problems. This position is complicated even further when it is then superimposed upon the current network of over fifty separate factories with over 800 active users, over 500 of which are disabled in one form or another. This level of complexity within an organisational structure, together with such a unique ERP community, provides a valuable environment within which to undertake this research, generating knowledge to benefit both the management and professional communities in general, as well as similar disabled employment organisations.

Review and Development of the Research Questions

The ways in which the research questions have evolved during this study reflects the maturing nature of the research. Questions one to three emerged from the proposal and planning process within Document One, whilst questions four to six were developed from the literary review and conceptual framework in Document Two. The total quality management philosophy of 'right first time' is a guiding principle that has influenced one's approach to this subject and from this two further questions, seven and eight, emerged during Document Three: They are all reproduced below to provide a vision of this evolutionary process

1. What are the attributes of data quality with particular reference to ERP?
   - What is data quality?
   - How does it impact upon enterprise resource planning?

2. What is the range of factors that impinge on data quality?
   - What are the elements that effect data quality?
   - How can data quality be measured?
   - What levels of data quality are necessary?
   - What do organisations need to do to improve and sustain data quality?

3. Are there specific factors that apply to these in the context of Remploy and related organisations?
    - How can the study be best related to Remploy?
    - Does Remploy's position make it unique or can common practices be applied with or without modifications?

4. What is the impact of poor quality data?
    - What is the true cost?
    - What are the benefits of improved data quality?

6. How can a data quality improvement programme best be implemented with regard to?:
    - The management of organisational change
    - The management of organisational politics and culture
    - The education, training and development of people
    - Remploy-specific issues (tie in with 3 above)

7. How can an organisation improve data quality by preventing problematical or erroneous data from entering the data flow at source?

8. How can an organisation maintain and sustain any improvement identified and implemented from the answers to the above question?

A further question- No 5 'How can the concept of 'World Class' be related to ERP and Information?' was rejected within Document Four as being too vague and imprecise.

Given that the stated aim of this study has been the investigation as to how data quality process improvements can be sustained per se, then a review and refining of these research questions is of vital importance. The research questions have so far been depicted in somewhat of a linear nature, but now it is felt that a degree of structure and prioritisation needs to be applied together with a pruning of those questions which are not seen as totally fundamental to the final focus of this document. Document Three inspired the development of research questions seven and eight and Document Four confirmed these as the main priorities at that time. However it is worthwhile debating the validity of both these questions in the light of ongoing research and experiences. Question seven states "How can an organisation improve data quality by preventing problematical or erroneous data from entering the data flow at source?" This encapsulates the total quality concepts "getting it right first time", "up-front error prevention", "up-stream solutions", data defect prevention" and "root cause analysis and prevention". However poor source data is not the only cause of data quality problems. It is appreciated that this question may be geared more towards the 'intrinsic' data dimensions relating to accuracy/validity, believability and objectivity, rather

towards timeliness, relevancy, accessibility or security and those data quality problems can pervade the entire dataflow chain, not just at the beginning. Whilst one is fully aware of the dangers of attempting to take a too wide a view within a single research project, one can argue that question eight "How can an organisation maintain and sustain any improvement identified and implemented from the answers to the above question?" is too restrictive and the final critical research question may be better stated as:

"How can an organisation create an environment where data quality improvements can be sustained?"

People, Processes and Data

Fundamental to the progress made so far has been the identification, within Document One, of three conceptual elements seen to be key to any data quality programme namely: People, Processes and Data. This was then developed further within Document Two to form the basis of the conceptual framework- Figure 2 page 18. This research has so far indicated that there are a myriad of methods and solutions to improve *data* quality in both the areas of transactional and master data at various levels embracing both *process* and *people,* with varying consequences and degrees of success. Nicholaou (2004:44) identified that lack of people training and failure to recognise the effects of an ERP system on current business *processes* are the most important culprits in problematical implementations. Whilst all such initiatives have enormous merit in themselves, they will not generate long term success or influence unless they can be embedded. This study takes note of these theories and practises that can improve and create quality data, but the main focus will be on attempting to identify how an organisation may be able to create an environment where such data quality improvement initiatives may be sustained. In this it accepts that there must be a climate where such improvements should be sought-after, generated, supported and implemented with adequate resources.

Theory and Practice

The objective of any DBA is to improve business, management and professional practice, by developing the students' personal, intellectual and academic abilities, together with their personal managerial practice, by studying work based issues or problems (NTU DBA Course Members' Handbook 2005: 6). By acquiring new knowledge, the student is in a position to bring about professional change, which in turn has the potential to create new *organisational* knowledge. This is unique to the 'professional' doctorate, but there is in fact further potential to reciprocate the process by making such findings available to be incorporated into the body of *academic* knowledge. Over forty years ago Simon (1967) argued that business schools have a dual mission, to develop new knowledge that advances science and improves practice

Simon (1967:1) and to address the problem of bridging the gap between the social system that develops scientific knowledge and that which consumes it, i.e. professional practice (Simon 1967:16). Attempts to bridge this gap between the fields of theory and practice have generated considerable discussion within the literature. Rynes, Bartunek and Daft (2001: 340) described the wide gap existing between research and management practice, arising from the reluctance of organisational executives to take account of academic research findings and the unwillingness of academics to undertake practice-related research. Van de Ven and Johnson (2006a) focussed on the relationship between theory and practice and proposed a method of 'engaged scholarship' Van de Ven and Johnson (2006a: 803) to enable practitioners and researchers to co-produce knowledge that can advance both theory and practice. This was debated further by McKelvey (2007) and Van de Ven and Johnson (2006b) culminating in Van de Ven (2007). One believes that this research has identified a gap in the literature and therefore has the capacity to add to the current body of managerial and professional knowledge within the realm of planning and information systems. This will be discussed later in this document. There is also an intention that such new knowledge should also be made available to benefit academic and science theory.

The first four documents have unearthed and developed certain essential key concepts and frameworks and it is now essential that these be defined, as they will form the basis for the further research and the development of the final findings, conclusions and recommendations.

2. CONCEPTUAL THEMES AND FRAMEWORKS

The conceptual framework and the major conceptual themes were developed in the main within the first two documents and even after continuous re-appraisal during the subsequent research they have remained largely robust, subject to minor refinements and modifications.

Conceptual Framework

The conceptual framework depicted in Figure 2 below sets Data Quality firmly within the overall context of Data Governance as part of an enterprise-wide data strategy and acts as a route map through the on-going research minefield.
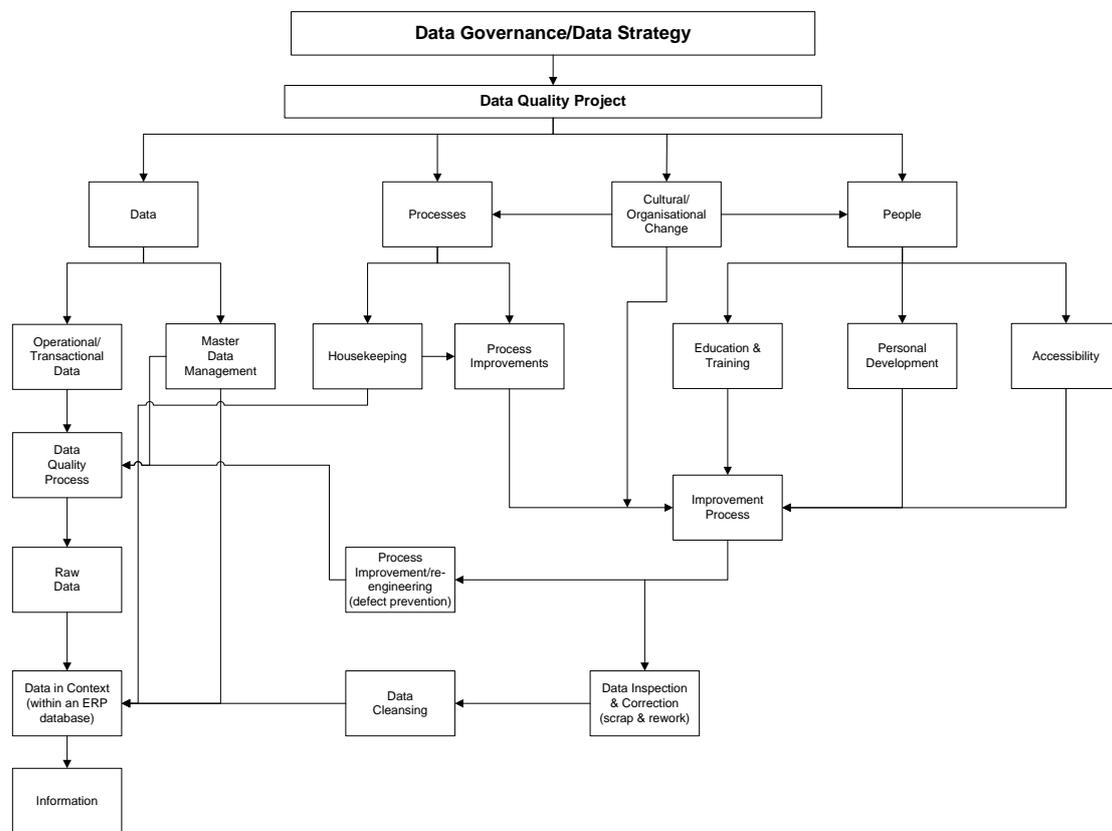
Figure 2. Conceptual framework

The initial triple inter-linked framework was developed from an intensive review of the literature and comprises the 'Data' elements of master data management, together with operational and transactional data; 'Process' review and improvement initiatives running in tandem with the necessary system housekeeping procedures; together with the 'People' elements of education and training, personal development aligned with accessibility in the form of Assistive Technology (hardware and software techniques developed in order to assist visually or physically disabled persons gain access to information technology within the working environment). During the research for this study it became apparent that any enduring improvement is predicated on making lasting changes to both processes and

individuals' behaviour and to bring about this, there has to be cultural and organisational change mainly through the interaction of leadership and management at all levels. The conceptual framework has therefore been updated to place 'Cultural and Organisational Change' in a position to influence the concepts of 'People' and 'Processes' as well as the overall 'Improvement Process' element. The framework also identifies how the process of producing quality information derived from quality raw data has parallels with a generic product manufacturing process. This useful analogy between a production process and an information system also has strong roots in the literature (Strong, Lee and Wang 1997:104; Wang 1998: 59)

Major Concepts

People, Processes and Data

The fundamental inter-relationship between People, Processes and the Data, which has been a guiding principle from the very start, requires that any attempt to improve the overall quality of data within any organisation must be centred on *people* whether data suppliers, processors or information customers; the *processes* that receive, handle, action and pass on *data* and *information*; as well as the *data* itself where ever it sits within the data cycle of input, process and output. Data quality improvement is not just about fixing data or improving quality within a single business application or process, but also about taking a more expansive and forward-looking enterprise-wide approach. This must involve addressing cultural issues, initiating both short and long term *process* and procedural improvements by a step-by-step, incremental approach, whilst ensuring that the *data* conforms to appropriate specifications or requirements. In this way any improvement initiative has an opportunity to be sustained. It has to be appreciated that there cannot be a 'one size fits all' remedy to embedding organisational improvements at all levels, but rather to identify appropriate solutions to fit individual situations and circumstances. One accepts that data quality problems are not created intentionally by *people,* but more by the failure of the surrounding *processes* whether these are system related or individual related involving lack of education, training, personal developments or purely the person being placed in a position for which they are not suited. There is strong evidence to indicate that solutions exist to improve the quality of data, emanating from both the academic fraternity and the commercial world and this project attempts to embrace both these arenas in the true spirit of a DBA. This research therefore has not only a strong academic base but also has major practical implications which leads to a further key theme, that of aligning robust theoretical and academic concepts, within the operating environment of a real life organisation, in order to implement sustainable data quality improvements. Both Van de Ven and Johnson (2006a) and Van de Ven (2007) focussed on this relationship between theory and practice and how each discipline may inform and thereby benefit the other, within a single project. It is also recognised that research

in this specific area may have implications for other functional sectors where process improvements programmes can be applied.

Generic Process Model

As indicated earlier, strong parallels have been drawn in the previous documents between the concept of a planning and information system and that of a manufacturing system (Strong, Lee and Wang 1997:104; Wang 1998: 59 and latterly Pham Thi and Helfert 2007: 6). The principle elements are highlighted below within what may be termed a Generic Process Model to compare and contrast the various elements:

Generic Process	Manufacturing System	Generic Information System	ERP Environment
Input	Raw materials	Raw data	People- Processes- Data
Process/ Operations	Production line	Information system	ERP Database
Output	Physical products	Information products	Information-People

The 'Manufacturing' or 'Factory' analogy is a useful model in that it takes a conceptual over-view of both generic manufacturing and information systems to identify ways in which established quality principles may be applied to the input and process elements ensuring that information products in the form of outputs conform to the requirements of their relevant customers. Strong, Lee and Wang (1997:104) identified three key roles within a data manufacturing system:

Data Producers:	Generate data
Data Custodians:	Manage, store and process data
Data Consumers	Use data and information

Within this context, however, one needs to be aware that the end products from manufacturing and information systems have differing implications, with the information production process viewed as potentially a more complex process than its physical equivalent (Pham Thi and Helfert 2007: 6). The outputs from a factory are unique one-off products which can be consumed only once, whether they are finished goods or components requiring further work. The overall effects of poor manufacturing are somewhat limited, normally requiring a scrap and re-work operation. Some longer-term detrimental implications may occur including customer dissatisfaction or product contamination, but even these will normally be relatively localised and time-constrained. Output in the form of data or information products can be consumed in an infinite number of ways and be re-cycled continually. Poor data can act like a virus infiltrating all aspects of an enterprise's operations, re-occurring again and again, or lay hidden undetected within sub-systems in perpetuity. Data may also be used in ways for which

it was not created or intended, causing potential misalignment, errors or misinterpretations, resulting in potentially dangerous or catastrophic decision making (Senge 1992: 7; Orna 2005: 44, 144-150; Mutch 2008: 53).

Working definitions

Within the literature there are numerous studies that fail to discriminate between *data* and information Helfert (2001: 1), indeed a number of articles Strong, Lee and Wang (1997: 103); Wang (1998: 59); Wang, Allen, Harris and Madnick (2002: 1) stated specifically that the terms data and information may be used interchangeably. In a recent article, Madnick, Wang, Lee and Zhu (2009), this debate was once again discussed, affirming that there was still no real consensus between the two terminologies, although a tendency exists to use *data* to refer to technical issues and *information* to be applied to non-technical issues (Madnick, Wang, Lee and Zhu 2009: 2:2). However, whilst it has been established within the context of this research that the term 'data quality' refers to both the quality of data and information, it is important to establish working definitions for these individual integral elements to avoid confusion and to place them in their true context. The Generic Process Model above also identifies where data and information reside within the ERP and Information System models.

Data

Fox, Levitin and Redman (1994: 11-12) identified a number of definitions on the notion of data, citing: Blumenthal (1969); Fry and Sibley (1976) who both defined data as a set of facts. Davis and Rush (1979); Yovits (1981) referred to the way it can be obtained, as the results of measurement and observation; Dorn (1981) defined data as "the raw material from which information is developed", whilst Langefors and Samuelson (1976) and Burch (1983) referred to data as 'symbols'. The article, Fox, Levitin and Redman (1994: 11-12), then focused on the approach developed by the database research community citing the works of Mealey (1967); Kent (1978); Tsichritzis and Lochovsky (1982) and Loebl (1990) from which a framework of 'data items' were devised, comprising entities, attributes and values. Davenport and Prusak (1997: 9) defined data as "simple observations of the world, easily structured, captured, transferred and quantified" and Davenport and Marchand (2000: 165) as "signals about human events and activities". Whilst according to Brackett (1999: 2) data may be viewed as individual raw facts out of context, without any meaning. Within the context of this research, data is viewed as the raw material for an information manufacturing system and is best represented by the English (1999: 468) definition:

"The representation of facts, the raw material from which information is produced, when it is put in a context that gives it meaning"

Data in an ERP Database (Data in Context)

Data in context is data within the database and is no longer raw data, but it is not yet information. By residing within an ERP system it is easily identified as such whether it is master or transactional data. Brackett (1999: 2) described data in context as facts comprising raw data that can readily be understood, but unlike information has no relevance or time frame. It is data that is arranged and labelled.

Information

An article published in 1948 by Claude Shannon, 'A Mathematical Theory of Communication', helped establish the discipline of information theory, centring on the engineering problems of transmitting information over noisy communication channels or telephone lines (Wand and Wang 1996: 87; Sveiby 1998: 2). Shannon viewed information as merely the quantitative measure of communicative exchanges, concentrating solely on the transmission of messages within a telecommunication system environment, attempting to ensure that the message received by the recipient was exactly or as close as possible to that transmitted by the sender from the source (Losee 1998: 274). The focus of Shannon's study was centred upon the accuracy of the transmission and reception rather than the accuracy of any perceived meaning and subsequent understanding. Working within the fields of electronics and information science Losee (1998: 258) defined information as the transmission of knowledge produced by the interaction of processes, representing the sum of the value of the characteristics of these processes (Losee 1998: 259). This process theme is depicted in Figure 3 where the value of the output is informed by the input and its process Losee (1998: 265) mirroring the Generic Process Model discussed earlier.
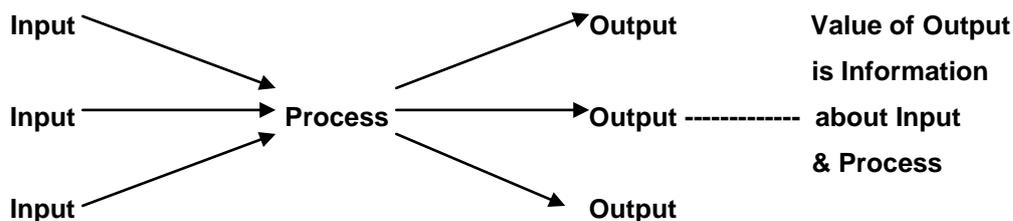
Figure 3. Information as an output of a process
Losee (1998: 265)

Peter Drucker has been credited with defining information as "data endowed with relevance and purpose" Davenport and Prusak (1997: 9), whilst Marchand (2000: 4) described information as the way people in business express, represent, communicate and share their knowledge with others to accomplish their activities and objectives. Davenport and Marchand (2000: 165) suggested that information is the outcome of the data as humans interpret and contextualise it, whilst Brackett (1999: 2) viewed information as a set of data in context that is

relevant to one or more people at a point in time or for a period of time. Boland, Tenkasi and Te'eni (1994: 459) identified the correlation between information and meaning as …..”the task of information systems is to support human inquiry as a process of subjective, interpretive, meaning making” and extends this further by stating that “Inquiry is the act of producing knowledge” (Boland, Tenkasi and Te'eni 1994: 462). Mutch (1996: 58) and Mutch (1997: 381) identified earlier definitions from Boland published in 1987 that information “is not a resource to be stockpiled as one more factor of production. It is meaning, and can only be achieved through dialogue in a human community”. Also “Information is not a commodity. It is a skilled human accomplishment” and “information is a thing to be searched for, stored and identified” (Mutch 1999: 327). Marchand (2000: 25-27) identified four ways that companies may use information to create value for business by: minimising risks particularly in the areas of marketing, finance, operational and legal; reducing costs by improving processes and transactions; adding value to customers and markets; and finally creating new realities by way of innovation and R&D.

Data can be stored in a system database but information cannot. The data becomes information when it reaches the public domain, that is, in the possession of the recipient from which one is then able derive relevance, meaning, purpose and knowledge.

Knowledge

Knowledge is internal within a person and only people can derive understanding and only people can be aware of meaning. Knowledge exists only in people's minds and reflects the outcome of the connectivity between a person's experiences and skills, with incoming information messages.

Checkland and Howell (1997: 86-92) proposed a single model encapsulating the process of turning data into knowledge detailed in figure 4 below.

	Selected	Meaningful	Larger longer living
Facts	or created		structures of meaningful
	Facts	Facts	Facts
Data	**Capta**	**Information**	**Knowledge**
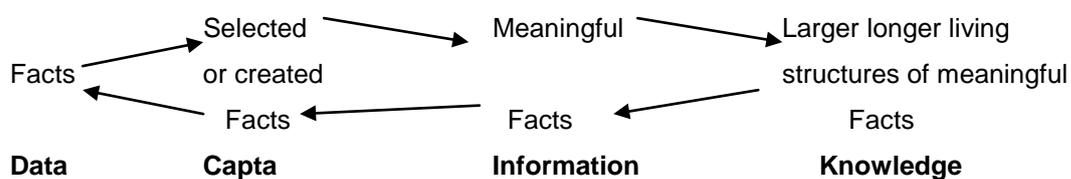
Figure 4. Data, capta, information and knowledge- three step process

Checkland and Howell (1997: 86-92)

The three-step process commences with *data,* comprising a mass of raw facts, from which part of the data is selected for attention as being useful and relevant and thereupon becomes known as '*capta*' (meaning 'to take'); this is then converted into *information* by having some form of meaning in context attributed to it albeit of a short term nature; the process is completed when information gains a degree of longevity within the mind of the recipient in the form of *knowledge*. The example can be used to model any data-to-knowledge environment.

The act of creating information and knowledge is seen as a human act, outside the scope of any machine. When applied to the context of an enterprise resource planning, or any other database system, it is only the processed *capta* (selected data) or (data in context as described above) that resides within the database. The model is useful in that the 'capta' stage provides a clear division between raw data and information particularly within a non-database environment, where the distinction may otherwise become blurred. It should be noticed that the higher arrows move the reader from the left (data) to the right (knowledge), then the lower arrows continue this clockwise motion returning the reader leftwards from knowledge back to data Checkland and Howell (1997: 86-92). In a similar way Mutch (2008: 63) suggested that it is *knowledge* that guides the researcher towards the *data* that is required and the *information* that will be extracted from it.

"Today's economy runs on knowledge" (Wenger 2002: 139). "Knowledge is information combined with experience, context, interpretation and reflection and is a high-value form of information that is ready to be applied to decisions and actions" (Davenport, De Long and Beers 1998: 43). Knowledge is information in peoples' minds Davenport and Marchand (2000: 165) or "valuable information from the human mind, including reflection, synthesis and context" Davenport and Prusak. (1997: 9), whilst Marchand (2000: 3) defined knowledge as "our experiences, skills, expertise, judgement and emotions".

Knowledge can be 'tacit' reflecting the knowledge within an individual or a collective such as an organisation and is often contained within the subconscious. It cannot easily be shared but has been found to be a strong foundation within the process of creativity and innovation. Explicit knowledge on the other hand is knowledge that can be articulated and shared and also it is claimed can be codified, stored and written down in manuals and procedures. Nonaka and Takeuchi (1995: 62) recognised that knowledge is created through the interaction between tacit and explicit knowledge comprising four modes of knowledge creation namely; Socialisation (Sympathised Knowledge), Externalisation (Conceptual Knowledge), Combination (Systematic Knowledge) and Internalisation (operational Knowledge) (Nonaka and Takeuchi 1995: 72). The interactions between the four modes can invoke a 'knowledge spiral' to create 'organisational knowledge', fundamental to which is the process of learning (Nonaka and Takeuchi 1995: 72).

Lave and Wenger (1991) described a learning process whereby individuals work and learn together in an informal way to achieve their common goals. This interactivity they term as 'Communities of Practice'. Every individual is a member of some form of community of practice whether they appreciate it or not Wenger (1997: 38), which will be essentially unstructured without necessarily a beginning or an end. The common bond between the participants is an informal shared passion and commitment towards a common joint

enterprise Wenger and Snyder (2000: 139) evolving into 'Communities of Action' Wenger and Snyder (2000: 140), being an effective vehicle for knowledge-sharing and knowledge creation (Hislop 2005: 70). According to Wenger (1997:38) "Learning is the engine of practice and practice is the history of learning". One may suggest that if this concept of learning and practice develops new knowledge to inform and improve individuals' and organisations' practice, then there may be opportunities in turn to inform theory in the manner suggested by 'engaged scholarship' (Van de Ven and Johnson 2006 and Van de Ven 2007).

Practical examples of the way the data to knowledge relationship can impact upon corporate performance may be seen where organisations use ERP transaction-driven data, coordinated with human-based information, to directly improve their marketing and enhance their knowledge about their customers, to generate improved business results (Davenport and Harris 2002:31). Davenport, Harris, De Long and Jacobson (2001b: 5) suggested a model for turning transaction data into knowledge and results, by way of three elements comprising: context, being the core organisational ingredients of strategy, skills, culture, and data; which are then passed through the transformational element where the data is analysed to assist in decision making; leading to the final outcome where action is taken to bring about change and effect results.

Research Focus

This discussion is extremely beneficial in establishing the interrelations between data, information and knowledge and in that context, enriches this research. However it should be noted that the literature tends to concentrate predominately on the outcomes, of information and knowledge whether tacit or implicit. This is also the case with references to business intelligence and management information applications which tend to be preoccupied with the ability to be able to slice and dice information in a myriad of different ways. In contrast there appears to be less interest in ensuring that the initial source material, data, and the processes that generate the 'outcomes', are of sufficient quality and robustness to provide recipients with meaningful enlightenment. This study attempts to take note of these discussions whilst placing them within the context of the overall research focus, that of creating and sustaining quality data within management, planning and information systems. Whilst highlighting this apparent imbalance in the focus of the related research, one has to acknowledge that a rich vein of material does exist around data quality, much of it unearthed during the literature review. In the context of this study it will be useful to return to this area.

Important aspects of the initial Literature Review revisited

As stated, Document Two carried out a thorough review of the literature surrounding data quality. The process proved very enlightening in that it identified valuable and meaningful

material which has provided the strong foundation upon which one has been able to build, to support this ongoing project; consequently a number of these articles are worthy of re-iteration. Wang and Strong (1996) examined data quality through the concept of data dimensions with particular regard to the requirements of data and information users, customers and consumers. Wand and Wang (1996) analysed data quality in terms of measuring deficiencies between two views of what is seen as the real world, comprising a view of the world as seen through a direct observation of events and a view inferred from the information system. Strong, Lee, and Wang (1997) identified the concept of a 'data manufacturing system' and the notion of data producers, custodians and consumers. Wang (1998) built upon this research in terms of an information system with inputs, processes and outputs, whilst Lee Strong, Kahn and Wang (2002) proposed a methodology termed AIM quality (AIMQ), using a 2x2 framework model to identify what quality means to information consumers and managers. The methodology is useful in identifying problems, prioritising areas for improvement and monitoring progress. Data quality was viewed by Pipino, Lee and Wang (2002) as a multi-dimensional concept requiring a quality assessment process which reflects such diversity using appropriate measurement, metrics and analysis. Assessing an organisation's data quality requires both a subjective and objective assessment. Both Orna (1996) and Wang (1998: 59) described the final output of a data manufacturing system as an 'information product', being the visible vehicle by which information is presented for use either on paper, in electronic form or in any other media, the 'telling' end of the scale (Orna 2001). A number of these articles were referred to by Madnick Wang, Lee and Zhu (2009) who presented an overview of certain examples of academic data and information quality research carried out over the preceding twenty years.

Sustainability

It will be beneficial at this stage to determine what is meant by 'sustainability' and define the context within which the term will be used. In general it may be seen as the ability to maintain the balance of a certain process or state in any system, viewed as either a 'journey' or a 'destination' within that system (Milne, Kearins and Walton 2006). The dimensions of sustainability are normally taken to be environmental, social and economic and within these three 'pillars' Adams (2006), they can be evaluated by means of quantitative reporting measures amongst them indicators, metrics, benchmarks, indices and audits (Hak 2007).

The above definition refers to 'maintaining the balance' which therefore leads the discussion as to what is intended by 'maintain' and 'balance' when applied to data quality improvements. By using any form of measurement one is implying that any result must be evaluated whether against a goal, target or even a general expectation, otherwise the metric is meaningless. Within the context of this study 'maintaining the balance' or sustaining improvements within this context has two possible meanings:

- Maintain the *actual* improvements made so far, from which there should be no decline, based upon the current measured result. A stake in the ground as such. This may be viewed as the 'destination' referred to above.

- Maintain the *momentum* of the improvements made so far, by continuing the trend and thereby looking to improve the current measured result further in the future. An incremental process and part of a 'journey', as against a final 'destination'.

The latter definition which is seen as a continual process, best fits the basic initial premise of this research.

Considerable discussion has already taken place within this study around the relationships between Data, Processes and People. It will be beneficial at this stage to examine the elements of each of these key fundamental concepts to analyse their drivers and enablers. Whilst *data* as an entity, has been debated above, the following section will place *Data* and the 'Management of Data' and Data Governance within the context of this overall research.

3. DATA, THE MANAGEMENT OF DATA AND DATA GOVERNANCE

Considerable discussion took place within the previous section around data, information and knowledge as entities and the efforts to develop explanations, sense and meaning to further clarify each of these elements. This section takes a narrower perspective looking specifically at the way *data* should be handled within organisations to ensure that it is both recognised as a enterprise-wide asset and managed accordingly to release its full potential and thereby maximise benefits to each organisation .

One view of data management is that it comprises all the disciplines related to managing data as a valuable resource. The Data Management Association (DAMA Data Management Body of Knowledge- DMBOK) DAMA (2009: 7) defined *data management* as "the development, execution and supervision of plans, policies, programmes and practices that control, deliver and enhance the value of data and information assets". The DAMA Framework includes: Data Governance; Data Architecture; Data Development; Database Management; Data Security Management; Data Quality Management; Reference and Master Data Management; Data Warehousing and Business Intelligence Management; Document Record and Content Management and Meta Data Management (DAMA 2008:11). Within the context of this research, one accepts that the Framework encompasses a great deal of the aspects surrounding 'Data' but believes that 'the term 'Data Management' is subordinate to the 'higher level' concepts of the 'Management of Data' and specifically Data Governance itself.

One has played a major role in the restructuring of Remploy's Data and IS strategy; in particular drafting the initial Data Governance and Master Data Management policies and it will be useful to place within the setting of this document, the paper setting out the basic concepts (Table 1 below). This initial policy document passed through a number of iterations prior to being approved by the Company's Executive, having been reviewed by Gartner Inc (Ted Friedman) with the comments: "Overall we believe your document is generally in line with industry trends and best practices for defining a data governance program" (Gartner 2009: 2). It is now intended that these principles will be developed and applied across all of the Company's applications. The concepts behind these policies can also be applied to any organisation.

The Management of Data and Data Governance

The Management of Data
Data is both an organisational resource and an enterprise-wide asset, as valuable as any physical, financial or personal asset and therefore must be managed appropriately. Its sole purpose is to serve the organisation to enable Remploy to attain its corporate objectives and goals.

Data takes two main forms:

Master Data

Data about the core business entities:

People: Customers, Suppliers, Employees, Partners, Clients

Things: Products, Items, Assets (including Buildings and Plant), Financials

Places: Factories, Offices, Branches, Employers

Concepts: Contracts, Licences, Polices and Procedures

Transactional Data

Data relating to our operations as we conduct business around sales, deliveries, purchases using the master data created above

Financial: Orders, Invoices, Payments and Revenues.

Work: Plans, activities

Logistics: Deliveries, Receipts

Employment Services: Job Progressions

For the purposes of this paper we are referring only to that data that interacts with any of our IS systems

Guiding Principles

We need to establish first and foremost guiding principles around the management of data. To be really effective we also need to identify and focus on those data sub-sets that hold real value and/or potential risk, rather than attempt to manage ALL of the data fields, much of which will be of low priority. This should be undertaken by establishing:

Ownership: Who has actual 'ownership' or 'custody' of the data on behalf of the organisation as a whole and thereby has responsible for the 'quality'

Responsibility: Those persons who are directly involved in any way with the entry, extraction, manipulation of any part of the data (as data suppliers, processors or consumers)

Management: Ensuring operational availability, security and business continuity- IS Department

Accountability: Everyone within the organisation

Data Policies: To be set by the organisation together with the 'owners' or 'custodians'

To ensure we follow these established guiding principles and work towards achieving our objectives we need to create a culture of Data Governance

Data Governance

The policy of treating data as an enterprise-wide asset assists in establishing a data governance strategy. The concept behind adopting a data governance approach is to enable an organisation to create an environment within which data is controlled and co-ordinated. As with most successful enterprise-wide initiatives, data governance requires a mandate, ideally in the form of sponsorship from a leading executive (Russem 2006: 19). Without a strong mandate for change, a data governance policy and indeed a data quality initiative, cannot hope to be successful. Data governance refers to the overall management of the data within an organisation involving, not only the security and risks associated with the data, but also determining who are the true owners and custodians of the enterprise's data assets, procedures, policies and processes; establishing the approach towards data quality and instilling a culture of data stewardship and quality through out O'Brien (2006:40); Russem (2006: 19), providing data quality and other data management practices with consistency, efficiency and a mandate within the enterprise (Russem 2006: 22). *Data stewardship* is the process of taking the data governance policies and initiatives and implementing them within the organisation at a task and operational level. In addition a comprehensive data governance programme should include other dimensions, specifically life-cycle management (Russem 2006: 19), incorporating archival, retention and disposal of data assets; privacy closely allied to security and data standards relating to the agreed policies. This is not just a data cleaning exercise but a culture change; the policies and initiatives need to be institutionalised so that they become part of the organisational fabric. However with this come the dangers of 'corporate politics' and inherent resistance to change, which can de-rail the entire process, if the mandate for change is not strong (O'Brien 2006: 40; Russem 2006: 19).

Data Governance Functions

People	Policies & procedures
Data Council	Data Quality Management
Data Owners	Data Security & Risk Management
Data Stewards	Data Privacy
Analysts	Exception Handling
Developers	Data Stewardship
Architects	Define Stewardship Guidelines
Data Suppliers	Life-cycle Management
Data Processors	Specific Data Policies & Procedures
Data Consumers	Specific Data Standards
Standard definitions	**Technology**
Data Definitions	Data Integration
Technology Standards	Data Profiling
Enterprise Data Model	Data Cleansing
Master /Reference Data Management	Metadata Management
Transaction Data	Data Modelling
	Archiving
	Security
	Privacy

Table 1a Data governance functions

(Developed from a presentation witnessed at (Informatica 2009).

Initial Data Standards

Initial gateway requirements for each project/application:

- Identify where the Ownership, Responsibility and Management of the data lies and ensure that this is communicate and accepted by all relevant people

- Establish effective procedures for cleansing and migrating data to any new application

- Identify the points where the project/application integrates with other applications. Communicate with the other projects to establish a clear strategy, procedures and governing rules as to how the data is to be integrated

- Establish KPIs and a monitoring process to measure the ongoing quality of the data

Master Data Management

The practice of acquiring, improving and sharing master data:

- There must be designated Business/Department/Personnel covering the Ownership and Responsibility for those elements of master data that are seen as being of value and/or potential risk.

- Those important fields must be identified and their implications understood. There should be a scoping exercise to identify these and those of low priority should so designated.

- Some tables cover more than one function- ie Customer & Suppliers have financial, logistical and analytical related fields. These must be identified separately

- It is appreciated that every field may not be mandatory but any 'blank' field must be designated and agreed as such.

- All of the above must be fully documented, approved by a designated authority (TBA) with a copy deposited within a central repository with revision control

- There must be an agreed common and consistent approach to address field content and avoid duplications

- This will form the basis of related operational processes and procedures

Examples

Master Data Tables

Table	Ownership	Responsibility
Existing Finance/ERP		
Customers	SSC/Business	Shared Service Centre
Suppliers	Purchasing/Business	Shared Service Centre
General Ledger	Central Finance	Finance Systems Team
Finance Tables	Central Finance	Finance Systems Team
Items	Relevant Business	Central Team (to be agreed)
Logistics Tables	Relevant Business	Central Team (to be agreed)

Manufacturing	Relevant Business	Central Team (to be agreed)
Distribution	Relevant Business	Central Team (to be agreed)
Employees	Relevant Business	Central Team (to be agreed)
CRM	To be agreed	To be agreed
New Applications		
Finance	As above	As above
ES Case Management	To be agreed	To be agreed
HR People systems	To be agreed	To be agreed

Transactional Data

The same process of identifying ownership and responsibility must also be applied to transactional data around:

- Need to ensure everyone is fully aware of the implications of their actions
- A complete understanding of the underlying system principles and requirements
- Being able to address root causes of issues and problems to ensure upfront error prevention
- Identify the personnel dealing with each type of 'order' and agree who does what with responsibilities for each process

Table 1 The management of data

Data Dimensions

A considerable amount of discussion took place within the initial literature review within Document Two surrounding data dimensions in particular around the study carried out by (Wang and Strong 1996). A detailed appreciation of the concepts surrounding data dimensions can provide significant assistance in improving data quality with particular regards to root cause analysis and process improvement. Tayi and Ballou (1998: 56) support this point by emphasising that data quality problems cannot be resolved without a thorough understanding of data quality dimensions. It will be beneficial to place the main data dimensions identified by Wang and Strong (1996) within the context of the one's preferred definition of data quality in Figure 5 below.

"Having the right and correct data in the right format, in the right place at the right time, by having one single version of the truth across the enterprise"

Right	Reputation; Objectivity; Value Added; Amount of Data Covered
Correct	Accuracy; Believability; Relevancy; Completeness
Format	Interpretability; Consistency; Understanding; Concise
Place	Accessibility; Access Security
Time	Timeliness

Figure 5 Data dimensions related to the definition of data quality

Kimball (2007:4) paraphrasing Michael Hammer in his 1994 book 'Re-engineering the Corporation' stated. "Seemingly small data quality issues are, in reality, important indications of broken business processes". This highlights the nature of data quality issues in that they easily mask wider significant process problems which can seriously affect a company's ERP system. The following section discusses the *Process* concept from both an 'operational' and a 'quality' perspective.

4. PROCESSES

This research has established the overriding importance of having quality processes in place within any organisation and this section places this concept within the context of enterprise resource planning, as well as generic business systems and discusses means by which they may be improved and enhanced.

Davenport (2005: 102) referred to processes as related tasks an organisation performs in order to carry out its work. Processes may be comprehensive and cross-functional, taking the form of a total end-to-end business process, for example a total 'order to pay' sales order processing operation (SOP), or they may have a much narrower perspective as a sub-process of the overall order processing operation. In a standardised format, processes may be viewed as individual building blocks brought together within a workflow to perform an overall task, with the exact number varying, depending upon the simplicity or complexity of the required outcome. Effective integrated processes are essential if an organisation is to derive full benefits from any application especially complex enterprise systems (Hammer and Stanton 1999: 111). This intricacy has potential to be further exacerbated in multi-location environments with high levels of inter-site activity as is the case in Remploy. Nicolaou (2004: 44) recognised the strategic advantages that can be achieved from enhancing business processes within enterprise systems, in the form of improvements in the availability and quality of information.

A standardised sub-process should ideally be the most efficient and effective method of performing the appropriate task and have synergy with its other related sub-processes to come together to bring about the overall result. In this way effective sub-processes can be chained together to create a situation where the whole is greater than the sum of the individual parts. One has to be mindful however that a total end-to-end process can cross functions and management fiefdoms with potential to generate conflict between the direct interests of a particular function and the overall interests of the entire process, leading to possible sub-optimisation. It is recognised that there is potential for such incidences to exist within Remploy and one's experiences have identified situations where this has occurred. It is hoped that one corollary of this research will be to waken peoples' awareness as to the consequences of such events and provide greater visibility as to where such incidents may occur.

Processes support an organisation's mission, strategy, goals and objectives and comprise a series of enablers all of which impact on performance (Sharp 2006). These enablers or levers can also be manipulated to bring about improvements. They comprise: workflows- those steps and sequences as to what is to be done, when and by whom; information systems using data processing applications; motivation incentives allied to measurement, with reporting indicators tied to reward systems; human resources, to engage the people

perspective via recruitment, training and development; business policies and rules, to govern the organisation and avoid sub-optimisation; and the facilities, relating to the actual physical environment where the work takes place (Sharp 2006: 8).

This research has identified two types of processes within the context of this study. 'Operational' processes, relating to the way in which master and transactional data within enterprise systems interact to both drive and react to the physical business operations as discussed above; and 'Quality' processes, essential activities that need to be in place to both improve and sustain the quality of the data overall. This study seeks to identify ways to cultivate and enhance the former whilst identifying, implementing and inculcating the latter. Whilst a great deal of the discussion within this section relates to generic processes, the principles can be applied equally to data and information, especially with regard to the objectives of this research.

Organisations have methodically monitored and evaluated process performance via a myriad of measurements either financial or non-financial to establish a guide as to the overall quality or as an indicator of the levels of change following any process improvement initiative. This information should then be disseminated across the relevant process owners to enable them to focus on their relevant areas. The process of measure, publicise and incentivise, can be very powerful especially if this is then tied to monetary or non-monetary rewards.

Process enhancement and change initiatives normally come under two, sometimes inter-related, categories. Quality management, often referred to as total quality management (TQM), is an incremental on-going/open-ended approach focussing on continuous improvements, sometimes involving minuscule ameliorations, which collectively can bring about large-scale improvements. In contrast re-engineering or business process re-engineering (BPR) normally takes the form of radical changes carried out within a fixed time frame and usually geared to resolve specific issues or problems (Davenport and Beers 1995: 58). The procedure may well involve a full root and branch review with a consequential mandate for change within all areas of an organisation (Hammer 1990: 112). The implications for TQM and BRP to influence this research are discussed in later sections.

Process improvement initiatives using 'double loop learning' utilising the format of action research have been in existence for a considerable period Argyris (1977) and was the focus of the research for Document Three. Loop One is the 'Performance Loop' which attempts to monitor day to day process performance, analyse and resolve problems and monitor trends; whilst the second 'Relevance Loop' looks to ascertain the significance and importance of the process and determine what changes if any are required (Davenport and Beers 1995: 63). The former takes a single dimensional view of the situation, whilst the latter attempts to observe from a wider and more strategic perspective.

The fact that small data quality issues are indicative of problems within business processes, as discussed in the previous section Kimball (2007: 4) enables us to focus our attention on the source of the data quality problems and identify paths to possible solutions. Whilst data quality problems tend to relate more to process issues, it is important to examine the *People* perspective and how this inter-relates with both *Data and Processes.*

5. PEOPLE ISSUES

The research carried out within Document Two, and evidenced by the conceptual framework (Figure 2 page 18) established the *People* related elements of Education and Training, Personal Development and Accessibility as fundamental to the success of any data quality project and this key concept will be discussed further within this section.

In common with a number of other observers Jantz (2001); Chen and Popovich (2003); Andress (2004); Morgan and Liker (2006); Whitehead (2006: 2) referred to the alignment between *people, processes* and *technology*. The author prefers to use the term *data*, as data quality does not require the medium of technology to make it relevant. Whitehead (2006: 7) observed that *people* are essentially unpredictable unlike the more controllable process flows. *People* need to change behaviour to bring about improvements and in this they can only be influenced and encouraged to generate the required motivation, especially within the environment of this study where human behaviour cannot be controlled. The dynamics of human behaviour all come into play, relating to an individual's personality, learning styles, conflict styles and means of communication to inter-relate with the over-arching organisational culture to attempt to bring about cultural alignment.

People as 'Users'

It will also be useful at this juncture to consider the term 'user' in reference those persons who interact directly with enterprise systems and IT applications in general. There has been some debate within the literature which contends that the expression 'user' may undervalue the skills and roles associated with such people whether they be data producers, custodians or consumers, with the implication that *data* is a mere commodity rather than the lifeblood of an organisation. English (2009: 42), quoting Peter Drucker and Stephen Covey, referred to the term 'Knowledge Workers' as well as 'Information Customers'. Bannon (1991:25-44) also sought to elevate the 'human factor', to rethink the concept of 'users', employing the term 'human *actors*' to imply less of a passive and more of an active controlling role. Lamb and Kling (2003:199) also challenged the 'user' concept, proposing a 'social *actor*' model to better facilitate future IS research (Lamb and Kling 2003: 224). Possibly a more relevant title may be 'system *actor*'. However the term 'user' appears to be inculcated into both the culture of Remploy as well as within parts of the literature, therefore within the strict confines of this study, eschewing the term is not considered to be a high priority.

People and ERP

All ERP implementation and optimisation programmes are ostensibly *people* projects and their biggest challenge is not related to technology, but to the *people* issues (Deloitte 1999: 10). The Deloitte (1999: 17) survey conducted amongst 99 large corporations, 90% of which

had annual revenues exceeding US$1 billion, found that 57% of the issues and obstacles were *people* related, most noticeably change management and the quality of staff and training. The necessity for effective change management figures predominantly in this study, identifying that success in this area is partly dependant upon adequate education and training. Training covers the basic skills that are necessary to use the system correctly, but education progresses this further by identifying, how the system will help the organisation (and thereby themselves) become more effective. This assists buy-in by enabling all individuals to see where they fit within the entire context of the system and how each can contribute to the overall success. If people understand their roles they are more likely to embrace rather than resist change. From that aspect of the literature which focuses on the more practical aspects of enterprise system implementation, optimisation and development, Goodfellow (1994: 46) identified education as the single most essential factor in determining successful or unsuccessful projects; similarly Wallace and Kremzar (2001: 16) recognised *people* as the key, the most important element within an ERP system and that it is those *people*, who are trained to use the right tools and to work together as a team, that can make the difference between success and failure (Wallace and Kremzar 2001: 142). Mohamed and McLaren (2009: 13-14) emphasised the importance of the 'soft skills' associated with ERP implementations, in particular strong change management, performance measures and rewards, employee morale and resistance, much of which tends to be overlooked within ERP education programmes. Discussion into these areas figures prominently in later sections.

Information Politics and Culture

Davenport, Eccles and Prusak (1992: 64) recognised that managing the politics of information is difficult, complex and time consuming, requiring detailed management attention together with changes in organisational culture. Five models of information politics were identified as being representative of the practices employed within information environments and are detailed below in order of increasing effectiveness (Davenport Eccles and Prusak 1992: 56; Davenport and Prusak 1997: 69):

Technocratic Utopianism: A heavily technical approach to information management stressing categorisation and modelling of an organisation's full information assets, with heavy reliance on emerging technologies.

Anarchy: The absence of any overall information management policy, leaving individuals to obtain and manage their own information.

Feudalism: The management of information by individual business units or functions, which define their own information needs and report only limited information to the overall corporation.

Monarchy: The definition of information categories and reporting structures by the firm's leaders, who may or may not share the information willingly after collecting it.

Federalism: An approach to information management based on consensus and negotiation on the organisation's key information elements and reporting structures.

The key is to match the organisation to the political structure that provides the best fit Davenport and Prusak (1997: 68), by ascertaining which model is currently in ascendancy within the organisation and to which model the organisation should be moving (Davenport, Eccles and Prusak 1992: 62). At the commencement of this study one's thoughts were that Remploy was hovering around the monarchy model with elements veering towards feudalism. Over the last five years there appears to have been a growing acceptance that quality data is important together with a need to conform to standards and one can now detects aspects of the federalism model emerging in all levels of the organisation. One feels that this study has assisted in this process.

Davenport and Prusak (1997:84) defined information culture in terms of the attitudes and patterns of behaviour that identifies an organisation's approach towards information. Culture has an important influence on how an organisation views and uses information (Davenport and Prusak 1997: 68). One has always viewed culture as 'the way we do things around here' involving beliefs and values. Corporate values themselves play an integral part in the development of an information culture. Remploy's 'five values'- keeping promises, respect, openness, professionalism and passion, by their very nature should support any change management initiatives directed towards data and information improvements.

Remploy has a proven track record within learning, education and training and each year all employees undergo a personal appraisal and development review, an essential part of which comprises a detailed learning and development plan, which is reviewed throughout the year. One area that has not been covered comprehensively, relates to Baan system training and the necessity for a Baan related education and training review has been identified. Such a programme was carried out within the implementation phase during the latter 1990s but has not been followed up fully on a regular basis. Over the intervening period key personnel have left and their replacements have been often 'trained' by others passing on bad habits and faulty work practices in some cases.

Implementing Improvements and the Management of Change

Data and information are very emotive subjects even within a static environment, but when one factors in elements of change, the climate becomes even more volatile. The finest data improvement initiative will flounder unless the process is managed correctly. Human and organisational factors are commonly identified as causes and contributors to failures and difficulties in implementing planned change. A study carried out by Lewis (2000: 151) identified that personal communication or the lack of it, plays a fundamental role in the

success or failure of programmes of change and that around this central core of communication, four key themes emerged relating to: creating and communicating a vision to highlight the purpose and intent of the change and to promote a shared understanding amongst those effected; sense making around the mission and the provision of adequate feedback facilities; establishing legitimacy for the change programme to important stakeholders; and communicating goal achievements, both as a means of publicising successes, and providing evidence of continued progress towards targets and milestones.

How do others implement change? A more detailed assessment of the aspects of organisational culture, politics and change management relevant to this study is discussed in the following section.

6. SUSTAINING IMPROVEMENTS AND THE MANAGEMENT OF CHANGE

The concept of sustainability has already been defined in Section 2 to mean an on-going journey of improvement where a continual upward momentum is maintained. One could use the phrase 'Continuous Improvements' although this may be interpreted by many to refer to the 'continuous improvement' *policy* known as Kaizen, the strategy of constantly introducing small changes in a business in order to improve quality and/or efficiency. Whilst this may be relevant to improving data quality it is viewed as a means to the end rather than the overall concept itself. This section proposes that any element of sustainability is predicated on being able to manage change successfully. In this context Helfert (2009: 949) identified that managing change effectively is fundamental to the success of business process management improvement programmes.

Zairi (2005: 4) defined sustainability as "the ability of an organisation to adapt to change in the business environment, to capture contemporary best practice methods and to achieve and maintain superior competitive performance" referring to the Quinn (2000) definition that sustainability is a "development which meets the present without compromising the future" Zairi (2005: 3). One appreciates the basic principles of the former definition particularly regarding the strong strategic ideals around best practice and improved competitiveness, but believes that it is not specific enough to meet the detailed requirements of this document, whilst the latter definition better supports the strong conviction that any short term initiative must never sub-optimise the future.

Any improvement process requires some form of change and all change needs to be managed. It is here where the triple concept of *people, processes* and *data* and the inter-relationships, has great significance. One can change a *process* (process change), but for this to become effective *people* are required to follow the new process (behaviour change). Where legal implications are present then enforced behavioural change may be required, but for the great majority of business change situations, further forms of acceptance and compliance are necessary. The greatest long term challenge facing any improvement change initiative is to ensure it becomes sustained, especially when this requires people to behave in new or different ways. The requirements for process change, behaviour change and the consequential culture change all have direct relevance to the conceptual framework

Depending upon the size and scope of the change, different strategies may be employed to engender acceptance and compliance. Boult and Eaton (2008) suggested: generating a belief that the proposed change is worthwhile and that the situation will improve; employing forms of temporary enforcement; measuring, analysing and providing feedback to ensure continued compliance; obtaining 'buy in' to generate individual ownership and belief; creating an environment which encourages and supports the new practices and celebrate successes; and building the changes into individuals' objectives, especially where this is allied to a

reward system. Additional management practices may be employed including the identification of the objectives, risks and benefits, with adequate communications to reinforce the messages to provide two-way feed back; involving all interested parties, canvassing their opinions; ensuring adequate training and development is delivered where applicable and making the necessary environmental improvements to equipment and facilities, to ensure returning to the old ways of working are deterred or prevented. Whatever strategy is put in place it has to be recognised that it is not a one-off event but a continuous on-going process.

There is a requirement to align the organisation behind any significant change and to become aware of this need to change, to accept the consequent responsibility and then to generate the necessary actions to adopt the new practices. Behavioural change requires adapting to these new habits and practices. This may be best initiated by focusing upon a few achievable goals with a sympathetic and willing audience, to test the viability and then to push forward with relevant interested groups, establishing and publicising relevant measures in order to build improvement with positive reinforcement.

Theoretical Models for Change

The literature has provided a number of theoretical models which have been developed to assist in making change programmes successful.

Formula for Change

The Formula for Change model attributed to Richard Beckhard and David Gleicher attempted to identify the chances of successfully implementing change in a given situation. The original formula was 'simplified' to make it more accessible for organisations to use Jacobs (1994: 122) and rewritten as:

$$D \times V \times F > R$$

If the combined elements of:

D = Dissatisfaction with the current situation

V = Vision of what can be achieved

F = First steps that can be taken to commence the change process

is greater than the initial:

R = Resistance to change

then within this climate there is a possibility that change can be implemented, but conversely if one or more of these elements are missing or deficient, then success is unlikely, as the resistance will overcome the attempt.

An organisation can develop the D, V and F elements by identifying and highlighting the critical negative effects and implications of the current position (D), creating an image of the

new future as a desirable and achievable goal (V) and identifying quick wins to get the process up and running immediately (F). Likewise the factors that comprise the resistance (R) can be identified and worked upon and in that way their effects may be lessened. Resistance can take a number of guises. There can be organisational resistance where the inherent culture works against any change or where there is seen to be other alternative options with greater priorities. Resistance may also be viewed as an organisational cost either in financial, time related or psychological terms where individuals fear change. Whichever implementation strategy is chosen it must continue to be employed until the change is fully inculcated.

Stages of Change Model

The Stages of Change model also known as the 'Transtheoretical' model was developed in an attempt to promote successful health related life style changes (Prochaska and DiClemente 1982). It focused upon the route to successful behavioural change and attempted to predict whether an individual can successfully change their habits and identified the potential inhibitors that may exist along the way. The model identified six to seven stages, from total inactivity, to a successful stable conclusion (Prochaska and Velicer 1997). In the first stage, 'pre-contemplation', there is a total lack of awareness and no intention to change. In the second stage, 'contemplation', there is awareness but no firm commitment exists. At the third stage, 'preparation', action is intended or planned, which leads to the fourth stage, 'action', where some change has been initiated. The fifth stage 'maintenance' represented that important phase where the initial up-front enthusiasm gives way to business as usual and with it the temptation to revert to type may exist, which can lead to a sub-stage of 'relapse', which if occurs, will necessitate a return to the 'action' stage to recommence the process once more. The final stage, 'termination', exists when the individual has finally inculcated in full, the essences of the new practice without any desire to return the 'old' ways.

Although the original model concerned itself initially with health related changes, since its publication it has been used within far wider ranging research environments and is now an established part of organisation theory and research to assist in bringing about sustainable change by training and support (Harris and Cole 2007: 778).

Kotter's Eight-Step Change Process

A change management model was developed by Kotter (1996), which encompassed an eight-step process, designed to cement change initiatives into an organisation's structure. The eight steps comprise: establishing a sense of urgency, to identify potential threats and opportunities, whilst obtaining management 'buy in'; creating the guiding coalition, to convince everyone that change is necessary; developing a vision and strategy, that everyone can understand and empathise with; communicating the change vision, in order to attract peoples'

attention and acceptance; empowering employees for broad-based action, to remove obstacles and identify areas of resistance; generating short term wins, to gain immediate momentum whilst also; consolidating gains and producing more change, by also taking a wider long term perspective of the overall project objective; and finally anchoring new approaches in the culture, to embed the change so that it becomes part of the organisational fabric (Kotter 1996 (33-158).

Management of Change

All change programmes will encounter disappointments and setbacks especially after the initial enthusiasm and euphoria has lapsed. It is vitally important that this is not allowed to de-rail the overall initiative. Fluctuations in results exist in all forms of life and improvement initiatives and change management programmes are no exception. It must be accepted that set backs and periods of stagnation will occur naturally as outside influences come to bear on any programme and this has to be accepted. The important thing is to put these into perspective and avoid overdue pessimism at all levels. Most change processes attempt to affect human behaviour, therefore psychological influences exist and feelings of pessimism, disappointment and negativity can produce damaging consequences. A positive solution-focussed approach may be employed to overcome such dangers and the programme champion or leader has to exemplify all of these positive characteristics. Any project has to accept that temporary set backs are the norm and that one should not become discouraged. None more so than within this study where this aspect will be discussed in later sections.

As part of a study into 'extreme value theory' Baum and McKelvey (2006: 166) investigated the daily closing prices of the Dow Jones and NASDAQ stock market indices from 1990 to 2005. They found that whilst there were daily fluctuations some with huge negative results, across the entire period there had been a continual positive upward trend. Applying this principle to the concept of managing change, one should not anticipate stagnation, but if it occurs one should focus upon the achievements made so far and continue to apply those principles that have worked in the past. This may require a re-focussing of the whole team with action plans and targets to generate further positive momentum. One also has to acknowledge however that not all improvement programmes will achieve any modicum of success. Some fail for various reasons and it is important to identify when this happens and then rethink the entire strategy.

A major study of organisations that experienced huge improvements in performance pointed to a common theme that of a build-up and break-though experience (Collins 2001: 165). The image of a flywheel was employed to illustrate the way that transformation is a continuous, cumulative process with no one defining moment, no single action, killer innovation or

revolutionary instance; but instead a step upon step, action upon action, decision upon decision, turn upon turn of the flywheel to bring about spectacular sustainable results.

Generic change management and sustainable improvement programmes can provide valuable lessons and examples for such initiatives within the field of data quality. Strong programmes are adaptable to numerous applications in many fields. Success is not easy. Research carried out by the Henley Management College indicated that around £25bn is wasted annually on UK improvement programmes and further research identified that upwards of 80% of such programmes fail to meet expectations (Eaton and Phillips 2006). One solution advocated having a defined methodology which outlines the proposed journey, communicates this clearly to all parties to specify the actions to be taken to create the necessary organisational environment, to enable the improvements to take hold. The organisation should then align itself behind these changes providing the necessary support to encourage and motivate both the individuals and the teams within which they operate (Eaton and Phillips 2006).

The change leader becomes the key, needing to have the respect of all related parties and be able to lead with passion. Change management programmes have to be seen to be alive and proactive, embracing emotions and exuding this passion, to stimulate acceptance and involvement so essential to win the necessary hearts and minds. Regular measurement, monitoring and reporting is also essential, as is the regular communication of the actions taken and progress made, towards the goal, whilst constantly reminding everyone of the criticality of the initiative so as to position the programme within the overall context of the organisation's objectives.

Having established the significant principles underpinning managing change to create a climate where improvements can be sustained, it is now important to place this discussion within the field of quality management together with data and data quality in particular..

7. SUSTAINABILITY AND THE PRINCIPLES OF QUALITY MANAGEMENT

This study has identified that there appears to be a gap in the literature surrounding the research into sustaining data quality improvement initiatives within an enterprise resource planning environment. There is a myriad of rich material embracing data quality per se and enterprise resource planning in general and its procurement and implementation programmes in particular. Likewise quality management and specifically total quality management, figures significantly in both academic and practical publications. The previous section identified that sustainable quality improvement initiatives involve managing change and these related principles are relevant to all forms of quality improvement whether product, service or data related.

This section examines quality management literature relating to sustainability with particular relevance as to how this may best be applied to planning and information systems. A number of the most relevant articles published over the last ten to fifteen years have been identified and their significance is reviewed below.

Dale (1996: 49-51) identified three key features relating to sustainability in the context of total quality management. In principle these related to: the relevant elements of TQM, amongst them leadership, infrastructure, quality systems and tools and techniques, measurements and communications; the continual process of improvement; and an organisation's ability to hold onto improvement gains. In a further article Dale, Boaden, Wilcox and McQuater (1997: 372), 'sustaining' was defined as 'the maintaining of a process of quality improvement'. The study identified certain important pitfalls around the lack of adequate leadership, management and problem-solving skills; failure to follow through on projects; the inability to keep teams together; and the lack of essential physical and technical resources, information and analysis.

Buch and Rivers (2001: 371) emphasised the importance of leadership and culture to the success of any TQM initiative, in partnership with training, reward and support systems to combat the natural tendency to revert to type in the face of both internal and external influences. This was echoed within an article published by the journal *Strategic Decision (2002)* which acknowledged that sustaining any new culture is extremely difficult and that leadership is crucial to the success of any new initiative, to ensure continued support and focus across the organisation and thereby influence the outcomes of the planned changes.

Wood (2004: 20) identified that achieving any degree of sustainability within a supply chain environment, required the direct involvement of those people who could make the changes with each accountable for their results. Allied to this was the requirement to provide a clear vision of the future, with targets and action milestones, supported by regular measuring and monitoring to provide feedback. In addition a number of enablers were recognised as having significance at an operational level namely: the formal documentation of all ideas and

suggestions for improvement; enabling teams to make local operational decisions; allowing time for daily housekeeping and improvement activities; with management staying focussed upon the overall improvement activities. The concept of enablers was developed further by Bateman (2005: 274), initially a process improvement approach was developed, which then evolved into continuous improvement programme to provide sustainability. Tactical and operational improvements at shop floor level were then implemented and integrated within the wider business scene, allied to a more organisational perspective.

A study by Balding (2005: 286) using an action research approach within a healthcare environment, found that when senior management were able to create a suitable culture to enable the middle management structure to become far more empowered and as a consequence more directly involved, this enabled the middle management team to take ownership and accountability for their part of the project, building upon their values to allow them to establish positive message within their teams. This helped counter major negative attitudes and thereby increased the opportunity for sustaining the organisation's quality improvement implementation.

Goyal and Patil (2009) described the building of an organisational quality mindset to bring about sustainable improvements. They identified that Lean Manufacturing, Six Sigma and TQM implementations may all suffer deterioration after the completion and handover of the breakthrough improvement unless the correct processes were put in place. The quality mind set proposed a programme of continuous improvement supported by: root cause analysis and prevention; regular management reviews by both local and senior management; institutionalisation of processes; daily measurement, monitoring and reporting; developing greater team work; all reinforced by the continual support of the top management. A strategic view provided by Svensson (2006: 25-29) used the term 'Sustainable Quality Management' to propose a 'circulation approach' which was seen basically as a chain or series of business improvement operations across three of total quality management's major components namely: core values, techniques and tools. The study also questioned whether the short term nature of these three components could conflict with the longer term aims of the organisation.

Zairi's (2005) study concluded that sustainable improvements can only be achieved by cultural and transformational change, with commitment and participation by everyone towards continuous improvement, developing skills, learning from experiences, celebrating success, all within an environment supported and reinforced fully by management at all levels. The entire process should be evolutionary, emphasising an organisation's critical success factors, supported by regular measurement and feedback, to develop a total quality management philosophy throughout the organisation.

Within the information system arena, Helfert (2001: 2) identified the importance of applying the principles of total quality management to inform the concept of a 'method-based data quality management' approach to improve the quality of data within data warehousing projects. This relationship between total quality management and data/information quality was developed further by Levis, Helfert and Brady (2007) identifying that whilst the majority of TQM researchers tended not to mention information quality explicitly, high quality data and information was critical to the success of quality management programmes. In a reciprocal manner it was also concluded that the principles of data/quality management are strongly underpinned by the concept of TQM (Levis, Helfert and Brady 2007: 9).

Sustainability and Enterprise Resource Planning

Whilst it has been identified that there is a gap in the literature relating to process improvement sustainability within ERP systems, certain articles have been published which contribute to the overall ERP/Quality Management debate. Laframboise and Reyes (2005) described research into the integration of ERP implementations and total quality management (TQM) systems. They identified that historically ERP and TQM had never been viewed as an essential pair and that there had been very little academic research carried out on ERP other than on procurement and implementation, which coincides with one's own findings. One relationship that was identified as being essential to both ERP and TQM was the critical support of top management and the devoted involvement of every employee. Whilst TQM and business process re-engineering (BPR) are both mentioned widely, there was never any reference made to 'data quality' as such. One questions whether this is a serious omission on behalf of the authors of the article who fail to identify the significance of data quality within a TQM concept, or the failure of the data quality fraternity to get its message across to ERP and TQM researchers.

Akkermans and van Helden (2002) debated the merits of two alternative methods to bring about ERP system improvements, comparing a 'strategic leap' approach akin to business process reengineering, with that of continuous improvement which (quoting Upton and McAfee (1997: 3) they defined as "a series of small steps whose individual impact might be small, but which cumulatively delivers substantial performance gains over time" (Akkermans and van Helden 2002: 4). The study compared the two alternative methods which were both employed within a specific ERP implementation, revealing that the use of the 'strategic leap' caused a major crisis within the organisation, which was only resolved when a 'continuous improvement' approach was employed. The article concluded that a continuous improvement process approach can have significant positive influences for both ERP implementations and post-implementation success (Akkermans and van Helden 2002: 19). Once again no direct reference was made to data quality which makes one question not only the ERP researchers and the data quality fraternity per se, but also the failure of the academic community's to take

any real interest in such an important topic, leaving an apparent void within this part of the literature

In a further study, Schniederjans and Kim (2003) examined the sequencing of business process reengineering and total quality management initiatives within a number of ERP implementations. Their research indicated that where BPR preceded the ERP implementation and was followed by a TQM initiative there was a fair element of success. This success was also mirrored in instances where the sequence TQM/BPR/ERP was employed. Reference was also made to 'Lewin's Three Phased Organisational Change Model' which may be characterised as 'unfreezing, changing, re-freezing' and how this model could be applied to their research. One appreciates that the very existence of any form of effective process development can act as a catalyst for a successful improvement programme. Worley, Chatha, Weston, Aguirre and Grabot (2005) studied the implementation and subsequent optimisation of an ERP system within a university, concluding that effective optimisation requires adapting business processes so that they align with the attributes of the human resources. Tasks and responsibilities have to be defined clearly, within consistent and optimised processes, taking account of the roles, competences, knowledge, requirements and potential of the workforce.

Davenport (2004) identified that organisations can derive significant benefits from enterprise systems implementations, provided they continue to optimise business and management processes. This may be achieved by establishing a continuous business change infrastructure with management involvement, working on a prioritised action plan, focussed towards ongoing process improvement; by standardising the operations, using best practices to ensure that they fit and flow effectively across the business, with appropriate measures and related accountability, to generate organisational value.

A study commissioned by Deloitte (1999: 21-23) found that successful companies demonstrated a number of best practices for maximising and sustaining the benefits of enterprise resource planning. Amongst these were: aligning the whole business behind the original vision and use the business case as an ongoing management tool; focusing upon the capabilities and benefits that have been identified from an ongoing perspective; ensuring that the most effective working *processes* are balanced with the new technology, to support the *people* who have been motivated, trained and developed; establishing clear lines of responsibility and ownership at all levels; together with the provision of measurements and metrics to evaluate progress against system performance targets and budgets. The study, termed 'ERP's Second Wave', also identified a series of generic steps to support ERP optimisation, to promote the benefits along with long term sustainability. These comprised a programme to: confirm the destination, where the organisation wishes to go; determine the progress made to date, where are we now?; develop a plan to continue the 'journey', with actions to be taken to achieve the goal(s); organise progress throughout the journey and

implement the action plans; create a means for tracking progress, measure, report and feedback the results, to determine whether the overall objective were being met. This may be seen as a derivation of the change management process of Plan, Do, Check, Act.

These last two sections have identified strong collective recurring themes arising from research within the generic Change Management, TQM, Lean Manufacturing and Six Sigma arenas some of which related to ERP environments. It should be noted that this literature review has focussed principally upon quality management and TQM mainly to the exclusion of business process re-engineering (BPR). One feels that this approach is valid because data quality is an ongoing life-time philosophy, more akin to the principles of quality management, rather than a collection of focussed, one-off or short term events to resolve business problems as is the case with the majority of BPR initiatives.

Key Recurring Themes

The key recurring themes have been summarised, referenced and grouped into a number of broad headings aligned to the main structure of the conceptual framework, in Table 2 below. Whilst the categorisation is not prescriptive and there may be some grey areas and elements of duplication, the analysis provides a summary of the main arguments and premises surrounding the notions of both change management and quality improvement, derived from the review of the relevant literature. This analysis will be revisited in Section 16 as part of the discussions emanating from this entire research.

Cultural/Organisational

Leadership:

Executive and Management support and sponsorship
Dale (1996); Kotter (1996); Buch and Rivers (2001); Davenport (2004); Zairi (2007); Goyal and Patil (2009)

Establish a clear vision with targets and milestones
Beckhard (1989); Kotter (1996); Deloitte (1999); Lewis (2000); Wood (2004)

Importance of Leadership and Culture
Dale (1996); Kotter (1996); Buch and Rivers (2001); Balding (2005)

Align the Organisation
Kotter (1996); Deloitte (1999); Eaton and Phillips (2006); Strategic Decision

Focus upon achievements
Kotter (1996); Lewis (2000); Zairi (2005)

Celebrate successes
Lewis (2000); Zairi (2005); Boult and Eaton (2008)

Management:

Improvement requires change which has to be managed
Kotter (1996); Lewis (2000); Bateman (2005)

A belief that change is worthwhile and necessary
Kotter (1996); Boult and Eaton (2008)

Manage the change
Kotter (1996); Deloitte (1999); Bateman (2005); Zairi (2005)

Identify risks, benefits and overall objectives
Boult and Easton (2008)

Plan and identify required actions
Deloitte (1999); Davenport (2004); Wood (2004); Eaton and Phillips (2006)

Measure, monitor with reporting and feedback to support accountability
Dale (1996); Davenport and Beers (1995); Deloitte (1999); Wood (2004); Zairi (2005); Boult and Eaton (2008); Goyal and Patil (2009)

A continual on-going process
Dale (1996); Akkermans and van Helden (2002); Davenport (2004); Balding (2005); Zairi (2005); Boult and Eaton (2008); Goyal and Patil (2009)

Accept that there will be set backs
Baum and McKelvey (2006)

Avoid undue pessimism, stay focussed and be positive
Balding (2005)

Identify potential pitfalls
Dale, Boaden, Wilcox and McQuarter (1997)

Manage any potential short term and long term conflicts
Kotter (1996); Sharp (2006) Svensson (2006)

Align the processes behind the people
Worley, Chatha, Aguirre and Gabot (2005); Eaton and Phillips (2006)

Establish clear channels of communication
Kotter (1996); Lewis (2006); Boult and Eaton (2008)

Manage the relationship between the way data interacts between the processes and the people
Deloitte (1999); Worley, Chatha, Aguirre and Gabot (2005); Whitehead (2006)

Processes:

Best practices within the right environment
Hammer (1990); Zairi (2005)

Continual process reinforcement
Dale (1996); Davenport (2004)

Elements of quality management principles in all forms
Schniederjans and Kim (2003)

Continual process improvements
Akkermans and van Helden (2002); Davenport (2004); Bateman (2006); Goyal and Patil (2009)

Root cause analysis and error prevention
Goyal and Patil (2009)

Concept of People, Processes and Data
Deloitte (1999); O'Brien (2006); Whitehead (2006)

Align the processes behind the people
Deloitte (1999); Worley, Chatha, Aguirre and Gabot (2005); Whitehead (2006)

Identify and document the process enablers
Wood (2004); Bateman (2005); Sharp (2006)

People:

Obtain buy-in, ownership and belief
Boult and Eaton (2008)

Involve everyone
Kotter (1996); Worley, Chatha, Aguirre and Gabot (2005); Boult and Eaton (2008)

Build targets into peoples' objectives with a reward mechanism
Sharp (2006) and Boult and Eaton (2008)

Importance of education, training and development
Deloitte (1999); Buch and Rivers (2001); Wallace and Kremzar (2001); Sharp (2006); Harris and Cole (2007); Boult and Eaton (2008)

Importance of ownership and responsibility
Balding (2005)

Teamwork
Wallace and Kremzar (2001); Goyal and Patil (2009)

Tendency for people to revert to type
Prochaska and Velicer (1997); Buch and Rivers (2001); Boult and Eaton (2008)

Concept of People, Processes and Data
Deloitte (1999); O'Brien (2006); Whitehead (2006)

Align the processes behind the people
Deloitte (1999); Worley, Chatha, Aguirre and Gabot (2005); Whitehead (2006)

Table 2 Key recurring themes

It has already been established in Section 2 that there is a correlation between the concepts of a manufacturing system and that of planning and information system and as such, one believes that the basic quality management principles and practices that have emanated from the manufacturing environment, much of which has been described above, have strong potential to assist in whole or in part, to manage effectively the quality of data within an ERP system. That being said, implementing and sustaining data quality initiatives requires processes, techniques and tools which will vary according to individual circumstances. One

size will not fit all, but these established generic quality principles and practices have the potential to be capable of being applied successfully across varied and diverse environments. This study will compare these strong themes emanating from the research detailed above, with the results derived from the qualitative and quantitative research, carried out within this project.

Data Quality Software Tools

This study focuses upon the manner in which *processes* and *people* interrelate around the *data* flows to impact upon the quality of an organisation's *data*. One is fully aware of the numerous software tools available which purport to improve data quality and there is considerable evidence that these tools do provide solutions in certain circumstances. However it is considered that such software tools are best applied once the basic principles of data quality management have been addressed and sustainable improvement processes are in the process of being applied. Therefore they are not considered to be part of this research.

The main research question for this entire study asks: "How can an organisation create an environment where data quality improvements can be sustained?" The ongoing review of the literature conducted for this research, has yielded rich material as to the notion of data quality as evidenced in detail in Document Two and in Section 2 of this document. Also the means by which quality improvement programmes in general may become embedded within organisations has been discussed in detail within Sections 6 and 7 above. This wealth of material combined with one's own professional and personal experiences has been used to frame the further research carried out for this study, in the form of both a qualitative study and a quantitative survey conducted within one's own organisation Remploy. The next section places into context the concept of data and data quality within the organisation and how this has developed over the last decade.

8. DATA AND DATA QUALITY WITHIN REMPLOY

As a prelude to the practical research undertaken for this study, this section presents a background to the way in which the organisation has approached the question of data quality and then provides an account of the improvement initiatives which have taken place over the last five years.

The Requirement for Quality Data

There has long been awareness within Remploy of the necessity of having accurate data within all aspects of the organisation, although for a period of time this was more of an aspiration than a reality. Following the implementation of the Baan/Infor ERP system between 1997 and 1999, data quality improvement efforts tended to concentrate on short term problem resolution in the form of on-the-spot, one-off training sessions and corrective actions as problems were discovered, together with data clean up exercises relating mainly to item, customer and supplier master data, all of which tended to be focussed on reactive problem fixing.

As the Company reorganised to move away from a historical structure of factory based businesses, to focus on a more product based structure with factories operating across two or more product businesses with far greater inter-factory trading it became more apparent that there were real data quality inadequacies. Superimposed upon this was the introduction of a far tighter month-end closure and reporting timetable. Originally ten working days, this was reduced to two and a half days over a period of four years restricting any time for the 'traditional monthly data clean up' exercise. This then led to a growing realisation of the need to 'get the data right first time'. Greater improvements in company reporting with the introduction of a new business intelligence reporting and budgeting tool led to a greater demand for structured reporting from a single source and a move away from individual ad hoc spreadsheet reports. This recognition of the need for far more accurate data emanated initially from within the Finance function where all the data ills tended to manifest themselves and with management frustration around the mistrust of the information contained within important operational and finance reports. New financial and non-financial reports and key performance indicators (KPIs) were introduced alongside quarterly business reviews to enable the Executive and each business management team to meet to review both past and more importantly future performance. With a far greater emphasis being placed on budgeting and forecasting, the need for accurate robust data was seen as paramount.

During the period 2002 to 2005 a number of initiatives were commenced around process improvements, one of which incorporated a partnership with Ashridge Business School under the title of '3X Project' embracing the 'Theory of Constraints' principles Goldratt and Cox (1984), which provided a basis for achieving dramatic improvements in factory performance.

The project was rolled out across thirty or so factories with varying degrees of short term and long term success. In certain sites it was met with indifference and resistance, whilst in others the changes were welcomed and acted upon. From the views of some of those involved, the deciding factors appeared to relate to; the ability of the project team to 'sell' the concept, the attitude and willingness of the local sites to accept fully something new, the degree of senior management sponsorship and open support (which did not appear to be prominent) and the lack of any ongoing measurement of progress and publication of results. The project itself had a finite existence but there is still evidence to suggest that in certain areas, improvements have been maintained over the last five to six years. It is felt that this was down mainly to cultural aspects of the individual sites where there was an immediate buy-in and in certain circumstances where actual physical changes to the factory layout prevented a return to the 'old' ways of working. This provided some interesting lessons around the subjects of process improvement and the management of change.

During the summer of 2005 the concept of data quality achieved a far higher prominence within the Company as an integral part of a new initiative, the Business Optimisation Project, supported by the Executive, the raison d'être of which was to coordinate the functions of manufacturing, HR, finance and IT to further optimise the operations of the whole organisation. Within this context quality data was seen as prerequisite to ensure that the existing Baan ERP system and allied applications should move from a support and control tool into one that could be used for the positive advantage of the businesses in providing accurate, timely and easily accessible data to allow the Company to better manage its assets and achieve its objectives. In hindsight this may be seen as the first real strategic awakening as to the importance of data quality to the organisation.

Data Quality Improvement

An initiative to raise the awareness of the essential requirement for quality data and instigate improvements across all businesses was launched at a finance department conference during the autumn of 2005 under the auspices of the author and the overall sponsorship of the Director of Finance. The various business finance managers agreed to act as conduits to drive forward the concept of data quality improvement within the areas of their responsibility. To assist in this, a small project team was assembled to initiate the improvement programme as part of the Business Optimisation Project described above. It should be noted that the term 'accuracy' was to be used instead of 'quality' and whilst it is recognised that accuracy is only a single element of the data quality concept as indicated in the section on data dimensions above, the entire finance team felt that the term 'accuracy' would have greater resonance within the business community and therefore have a better potential take-up and understanding. All of this in no way precluded the other elements of the data dimensions and the data quality definition from being integral parts of the programme. Over the intervening

period the level of awareness, focus and all-round general acceptance of the concept justifies this decision.

An initial approach was made across a number of fronts to attempt to promote education and training; documentation of procedures; the acceptance of responsibility, ownership and accountability at all levels for processes and data; together with better management of master data. In addition the identification and implementation of 'quick wins', together with selling the importance of the project up and down the corporate structure was also seen as being fundamental to raising and integrating the profile of data quality. Recognising that accurate source data was essential, it was agreed that the initial focus should be directed at the operational and factory level, concentrating on the essential operational and commercial activities from customer order receipt to final completion and payment and it was seen as imperative that these should be measured, monitored and controlled.

Remploy Data Accuracy Key Performance Indicators

To this end seven key performance indicators (KPIs) were established around the order fulfilment process, historically the sources of many of the data quality issues. The KPIs were chosen specifically to reflect the salient elements of these essential commercial operations. Two external facing measures were chosen relating to customers and suppliers, four others relating directly to processes within each factory and a final one involving both the sites and the central finance Shared Service Centre which oversees the Accounts Receivable and Accounts Payable functions. The KPIs were designed to reflect the view of the world as seen through the lens of the ERP system, compared with an *actual* view which could be obtained by direct observation of the actual physical order process. In other words how closely the 'system' (*data* within the ERP system) reflects reality in the manner described by Wand and Wang (1997: 94), whilst also providing a measure of the quality of the actual *data* and the related *processes*. Over and above this the information provided the company with the ability to track order fulfilment targets and identify late orders in the form of purchase receipts, production completions, sales despatches and invoice generation all of which have related data quality connotations with potentially serious financial implications. The KPIs have been used to monitor the levels of data quality over the past four years in particular to measure the success of the various data quality initiatives which are tied closely to this study, therefore it is important that their detail and implications are understood.

External Facing KPIs

The following KPIs attempt to identify potential problems emanating from customer/supplier trading which can affect not only the quality of the company data but also the inter-relationship between the company and its external trading partners.

Customer Credit Notes- The number of credit notes as a proportion of customer invoices. This measure can reflect inaccuracies in invoiced quantities, pricing, VAT charges, customer master data, delivery problems as well as product quality issues.

Purchase Invoices Under Query- This measure identifies those supplier invoices that cannot be matched and approved against a receipted purchase order. This process can be affected by inaccuracies in receipting goods and services, invoice pricing, supplier master data, failure to raise purchase orders, order line data and supplier invoicing errors.

Internal Facing KPIs
Site specific KPIs

The following KPIs relate to order fulfilment, identifying transactions that have not been completed on time and may have a serious impact not only on data quality but also potentially customer/supplier relationships.

Outstanding Orders: Production, Purchase and Sales- Identifies orders that are still not complete requiring further transactions to be carried out. These can be affected by inaccuracies in quantities booked, poor housekeeping (failure to complete/close orders), completion of back orders, failure to maintain receipts, record production and post despatches, as well as the effects of actual late order fulfilment.

Despatches Not Yet Invoiced- Indicates where goods have been despatched to a customer without an invoice being raised or where the invoicing process is still incomplete.

Site/Shared Service Centre KPI

This KPI relates to the inter-functional relationship between the various sites and the central Shared Service Centre. This measure identifies potential issues that can affect the quality of the overall data and relationship between the company and its suppliers.

Receipts Not Invoiced- Identifies the level of receipts that have been booked into stock or charged against costs that have not yet been matched against a supplier invoice. This can be affected by inaccuracies in booking in quantities or recording product returns, invoice matching, purchase order prices, supplier master data, or an incorrect supplier chosen. Whilst the overall responsibility lies with the originating site and business, the very fact that a portion of the transaction interfaces with the central Shared Service Centre means that there is an element of shared responsibility. The circumstances are further complicated by the fact that when a receipt is made, a financial liability is created which under current accounting standards means that any legitimate receipt must be retained as a liability for a minimum of six years unless otherwise agreed.

Measurement Process

When using any form of key performance indicator one has to ensure that it is viewed purely as a measure to monitor a given situation and not as the situation or problem itself. The KPIs

indicate a given position in this case the quality of the inherent data. The KPIs are intended to measure the improvement or otherwise in the quality of the data, the processes and the employees' activities. There is strong evidence to suggest that actions have be been taken in some sites solely to 'improve the score' which have subsequently proved detrimental to the sites' overall performance. Such actions which sub-optimise business performance must be outlawed.

The source data is extracted straight from the Baan ERP system each evening into a data mart from which the management reporting tool updates the KPI reports overnight in order that they always reflect the previous day's position. The reports take the form of numeric and graphical data. Although graphs and charts are useful in depicting trends, the main attention has focussed upon the numeric data which takes the form of detailed aged listings of each of the individual transactions which comprise each category and are reported by site, business and total company. It was accepted that the majority of recipients were not acquainted with the detailed workings of Baan so it was decided at the beginning, to set the data within the business intelligence reporting tool alongside the other factory and business reports for easy access, with the ability to view and print at any time. The detailed KPI reports were developed and constructed during late 2005 and early 2006 and were first made available in April 2006.

The importance of being able to measure progress was appreciated fully, especially as the seven components are somewhat disparate and so therefore it was decided to create a table to summarise all seven reports within a weighted index incorporating the concepts of the Balanced Scorecard (Kaplan and Norton 1992). The weighting was based upon the age of each transaction aggregated into thirteen monthly periods relating to the Company's annual accounting timetable, commencing with the current period, with the thirteenth containing transactions twelve months old and over. Each successive period was allocated a higher weighting in recognition of fact that transactions are more significant the older they become. The exception to this was the report covering credit notes as it was agreed that the position should be one of improvement and as a consequence the weighting was reversed with the newer periods receiving the higher weighting than older ones. After the end of each accounting period any outstanding transactions are then subsequently aged by a month. A separate index was produced for each site with an aggregated one for each business.

KPI Roll Out and Development

Initial Development

The KPIs reporting process was first made available initially from April 2006. In tandem, the weighted index was also being developed and finally completed in July of the same year. A very rigorous testing programme was carried out within all facets of the reporting mechanism. As part of this process individual pilot operations were run with a number of the businesses to

test the validity of the data, ease of use and understanding of both the results and the weighting mechanism. This process took a considerable period of time, recognising that it was imperative that any instrument designed to measure the accuracy of any data, MUST be totally error free, or all credibility in the measurement process would be lost forever. It was also appreciated that to ensure continuing on-going use and acceptance, the reporting should also be easy to use and understand from both the data source and the implications of the outputs.

Initial Reporting Process

The formal reporting process commenced in September 2006 with the publication of the weighted index initially on a fortnightly basis circulated to the senior members of the Finance Department and the Director of Finance by way of an email attachment. In addition, detailed guidelines were also published outlining the background and justification, together with instructions for use. It was agreed that each finance manager would be the focal point to cascade the initiative throughout their individual businesses and obtain the necessary buy-in at all levels. The reporting consisted of two high level summary reports comprising an overall index for each business and another providing the information by site within each business. A more detailed summary report was also added at certain times. During this initial period the researcher visited a small number of the business offices and sites to support the initiative.

Extension of Reporting Process

In September 2007 the circulation list was extended to incorporate the Business Managers and an additional member of the Executive Team, which raised the profile further. Every effort was made to try and ensure that this was viewed by all as a company-wide initiative and not a financial, IT or corporate project. Emphasis was placed on the fact that the data was *owned* by the businesses and that they were therefore responsible for its quality. Whether or not this was accepted at the time is a moot point. The reporting was further expanded in September 2008 to take in both the individual businesses' operations managers and the recently formed Operations Forum, a format to discuss operational issues and share ideas and best practice. One attended a number of these meetings where data accuracy was discussed. Further business penetration took place in January 2009 when all the individual factory and site managers were added together with certain relevant supervisors. Within this period the KPI Index was elevated in terms of management and exec reporting. In January 2008 it was included in the Quarterly Business Review meetings between the Exec and each business and in December 2008 individual quarterly targets were set and agreed for each business and measured on a monthly basis. A summary of the roll out is set out in Figure 6 below

Roll out of the Data Accuracy KPI Reporting

September 06	Finance Community and Finance Director

September 07	Added Business Managers and Exec member
September 08	Added Operations Managers and Operations Forum
January 09	Added Factory and Site Managers and certain support staff
January 08	Included within the Quarterly Business Review meetings (Business Management Teams and Exec)
December 08	Quarterly Index targets set for each Business

Figure 6 Data Accuracy KPI Index roll out

Review of the Reporting Process

The programme of expanding the circulation and overall corporate exposure depicted above may be considered to be somewhat ad hoc in that it did not conform to any initial detailed pre-determined agenda; rather, it developed and evolved over the period, in line with the researcher's own learning process, both as part of this study and as further development of one's practical business experiences. With hindsight the process may have been accelerated a little but the overall aim has been to inculcate rather than inflict the concept. It was also felt that it was important that it be seen as a cross-functional business-wide project rather than a centrally imposed reporting and control structure.

The Data Accuracy KPI Index is essentially a barometer of the effectiveness of the related processes they measure and not an end in itself. Any lasting improvement is predicated on the effectiveness and quality of the processes and the way in which any persons interacting with the processes adhere with the agreed requirements. If the processes are right the improvements in the KPIs should fall out as a direct result.

It was appreciated that this roll out was essentially a top-down process attempting to engage all the relevant elements of each business via the normal management channels of communication. The initial phase saw a high degree of success, which continued in a number of areas due mainly to the enthusiasm of certain managers who were really passionate about the subject seeing real practical merit in what was being attempted. It became evident in 2008 that not everyone was on board and that the real message had not being delivered deep into all the factories and business offices. A Modernisation Programme had taken place during the early part of 2008 with the closure of a third of the sites and the restructuring of a number of businesses, coupled with certain key staff choosing to accept or volunteer for redundancy, all of which took place within a six to eight month period from March 2008.

Whilst the Modernisation Programme achieved its strategic, financial and operational targets, a natural outcome was the understandable re-focussing of everyone's objectives onto the new structure and the related business development projects. As a result the data quality

initiative found itself competing for peoples' focus with other equally if not more personally pressing priorities. A consequence was a rapid decline in the overall quality of the data as measured by the data accuracy KPIs and a general concern that the overall momentum had somewhat dissipated. It became evident that a re-launch was required and this would be best achieved by attempting to communicate at a factory and business office level with the relevant business and site managers and their relevant teams. This was seen not just as a means of promoting the data accuracy reporting, but as an opportunity to engage with those individuals who acted as the 'data producer/custodians' in addition to 'data consumers', to promote the ideal of data quality and obtain their views, input and feedback into the overall concept of data quality and its sustainability. This process formed the internal qualitative study using an action research approach detailed below in Section 11. Site visits had taken place previously on a number of occasions on an ad hoc basis, but not as part of any comprehensive, planned project. The progress made through the initial two years of the programme indicated that whilst there was enthusiasm in many areas towards the concept of data quality, such interest was mainly tacit. This meant that real progress towards creating any degree of sustainability faced many challenges. This research has attempted to identify and explore these challenges to determine ways to create an environment for enduring quality data.

Having established the context within which the research is to be conducted, the following section explores the approaches to both the qualitative and quantitative research.

9. THE OBJECTIVE OF THIS RESEARCH

The objective of this research is to discover the means by which the quality of data can be improved, but more fundamentally, become embedded within an organisation. This study used a dual research approach employing both qualitative and quantitative research strategies focussed within the researcher's own organisation. Such multiple methods of enquiry are capable of knitting together different types of evidence Williams and Pollock (2009:14) to produce more robust and richer understandings (Williams and Pollock 2009:15).

Internal Qualitative Study

Action Research

It was decided to employ a qualitative site-based action research approach to involve and engage with those colleagues who interact with and influence the quality of the data at source, being the method most likely to produce the essential insights into peoples' perceptions (Eden and Huxham 1996:82). Action research, as the title implies, focuses upon action to promote and manage change, based on the philosophy of learning, planning and then taking action in order to change a part of reality (Jarvinen 2005: 13). Lewin (1946: 42) saw action, research and training as a triangle, emphasising that to improve the actions one must first train the personnel. Lewin (1946: 38) identified research as 'fact-finding' or 'reconnaissance', a means of ascertaining whether one is moving in the right direction and at what speed, involving four stages to: evaluate the action; gather new insights; plan the next step; as a basis for modifying the overall plan. This was seen as part of a 'spiral of steps', each "composed of a circle of planning, action and fact-finding about the result of the action" (Lewin 1946: 38). Kemmis (1993:3) suggested that action research provides a way for people to enhance their lives through a research process that widens their social structures and related processes, being a pragmatic approach which looks to come to terms with the world (Baskerville and Wood-Harper 1996: 239); Fisher (2004: 45-46) emphasised the aspects of learning from experiences, by taking action and monitoring the consequences and then developing and promoting improvement and change within an organisation. Bryman and Bell (2003: 304) identified action research as a real life experimental process enabling an organisation to solve problems through a process of identification, planning, action and evaluation. This may then lead to the re-education and the changing of peoples' patterns of thinking via action through participation, thereby contributing to both academic theory and practical action Bryman and Bell (2003: 304), This link between theory and practice then becomes relevant to both the practitioner as well an academic audience Eden and Huxman (1996: 83), simultaneously assisting in practical problem solving and expanding scientific knowledge (Baskerville and Wood-Harper 1996: 239). This again echoes the sentiments of 'engaged scholarship' developed by (Van de Ven and Johnson 2006; and Van de Ven 2007). Indeed Van de Ven (2007: 281-2) identified action research directly as a form of engaged scholarship.

Action Research within Planning and Information Systems

Action research is not a unique approach within ERP systems, however the majority of the literature has followed the established trend and focussed upon ERP procurement and implementation Akkermans and van Helden (2002); Stefanou and Revanoglou (2008); Walsham (2006); Beyon-Davies, Baker and Williams (2008); Deep, Guttridge, Dani and Burns (2008); Bohorquez and Esteves (2009) and system enhancement Klueber and Alt (2000); Adams, Baker, McFadzen, Miller and Smith (2004), without any real focus upon the quality of the data.

Whilst action research figures within the information systems literature Baskerville and Wood-Harper (1996); Baskerville and Wood-Harper (1998); Baskerville (1999); Lau (1999): Kock, Davison, Dias Figueiredo and da Cunha (2002); Stirling, Petty and Travis (2002); Kock (2003); Baskerville and Myers (2004); de Vries (2007); DeLuca, Gallivan and Kock (2008), there is a distinct lack of any direct reference to data quality. The use of action research approach within information systems research is considered to be "very appropriate" Baskerville and Wood-Harper (1996: 235); "the most scientifically legitimate approach available" Baskerville and Wood-Harper (1996: 240); "a rewarding experience" Lau (1999:170); "a potential avenue to improve the practical relevance of IS research" Baskerville and Myers (2004: 239); whilst DeLuca, Gallivan and Kock (2008: 66) anticipated an increase in the use of action research over the following ten years. The potential for action research to contribute to theory and practise is also emphasised (Baskerville and Wood-Harper 1996: 239; Lau 1999:170; Kock, Davison, Dias Figueiredo and da Cunha 2002: 1; Baskerville and Myers 2004: 330; Jarvinen 2005: 4; de Vries 2007:5; DeLuca, Gallivan and Kock 2008: 66).

The Application of Action Research within this Study

One must not underestimate the potential tensions that exist when employing an action research approach, in particular where research projects are being carried out by part-time students working within their own organisation in a work-based environment. This is further exacerbated within this study by the fact that this research is not being undertaken purely for academic purposes but alongside an actual ongoing operational improvement programme, making this study very much a form of 'participatory' action research. Coghlan (2007:335) discussed such 'practitioner doctorates' where middle or senor managers carry out doctoral research within their organisations, employing an action research approach, combining work and study. Within this context Bryman and Bell (2003:305) described three interrelated issues associated with, the pre-understanding of the setting, role duality and organisational politics. Coghlan (2007) and Roth, Shani and Leary (2007) discussed these issues in detail within the framework of research into *insider* action research. Being an 'insider' with a pre-understanding of the organisation, the researcher may be too close to the data Roth, Shani

and Leary (2007: 47), finding it difficult to stand back (Coghlan 2007: 339). The dual roles of organisational member and researcher also have the potential to cause conflict (Coghlan 2007:339; Roth, Shani and Leary 2007: 51). Roth, Shani and Leary (2007: 51) also identified a third role, that of an 'internal consultant'. Organisational politics also play a part with the potential to undermine or block planned change (Coghlan 2007: 340). The 'internal researcher' or 'political entrepreneur' Coghlan (2007: 340); Roth, Shani and Leary (2007: 44), has to appreciate and understand the workings and culture of their organisation Roth, Shani and Leary (2007: 58) and have credibility to be able to achieve 'buy-in' from colleagues (Roth, Shani and Leary 2007: 58).

Whilst one appreciates the reservations and caveats discussed above, one feels that a researcher working within their own known professional environment has the opportunity to generate rich and valuable findings to benefit both the research outcomes and the organisation as a whole. Within this study, role duality was not considered to have negative consequences; it was felt that a 'sympathetic' pre-understanding of the setting, knowledge of the organisational politics and a reputation for providing help and advice in the past has the capacity to make the process credible, to generate considerable buy-in from participants, avoiding conflict, and thereby make change and learning possible. Whilst it is accepted that being 'close' to the data with the inherent difficulties in being able to 'stand back' may cause possible problems, it is felt that this should be overcome if the researcher is aware of such potential issues and allows the participants freedom to become involved and contribute fully. Every effort was made to ensure that this happened.

Given that this study employed an insider action research approach where the researcher had intimate knowledge of both the business processes and the Baan application, there was a distinct danger that one could become the 'major source' of the solution. To guard against this, one made every attempt to ensure that as many participants as possible had the opportunity to make a contribution. There were occasions where one's advice and opinion was sought as part of the general discussions and in such circumstances a response was provided. Every effort was made to ensure one remained objective and that one's views were never imposed upon the proceedings. The positive responses from each meeting appear to be evidence that everyone felt that they had made a positive contribution.

Whilst undertaking work-based research one must also place this within the areas of theoretical inquiry. Both Bryman and Bell (2003:304) and Eden and Huxman 1996: 80) suggested that there appears to be little difference between the roles of an academic researcher and a management consultant and action research and consultancy. (Eden and Huxman (1996: 79) also identified and discussed two groups, the 'consultant as researcher' and the 'researcher as consultant', both reflecting a practical orientation although satisfying different audiences. The former, which seeks to bring about improvement by forms of

'tweaking' to improve practice Eden and Huxman (1996: 79) is viewed as closest to this research, although in the light of a previous discussion, the term 'practitioner as a researcher' may to be more apt. Whilst action research does not lend itself to repeatable experimentation and has not traditionally been seen as an ideal means for the rigorous testing of theory Eden and Huxman (1996: 80), it does have the powerful potential to generate rich data around people and their actions Eden and Huxman (1996: 80) especially within this context, where it may be seen to have enhanced this research, as will be discussed further in Section 17.

Within this study the process of action research is seen as the means of developing a deeper understanding of the organisational conditions within which the quality of data can be improved, by colleagues working together towards a common accepted goal in terms of a 'collective involvement' to manage organisational change (McNiff 2002: 27). In this context the action research process leads to individual learning not only by the researcher but by all participants in the form of 'organisational learning' (McNiff 2002: 28). Without this element of collaborative action learning any improvements would have little chance of any degree of permanency. Action research may be seen as the external collective 'We' element whilst action learning relates to the internal 'I' allowing the external experiences to become inculcated.

In Figure 7 below McNiff (2002: 7, 11-12) provided a generic action research model, depicted diagrammatically in black, which underscores the salient points surrounding action research and also provides a very practical action plan for applying the concepts. This has then been adapted to relate more closely to this study as detailed in blue, to which has been added a 'return loop' in red to represent each subsequent site/business meeting following similar processes, hopefully learning from the prior experiences. One may also see a direct correlation with the quality management cycles of Plan, Do, Check, Act (PDCA- TQM) and Define, Measure, Analyse, Improve, Control (DMAIC-Six Sigma).
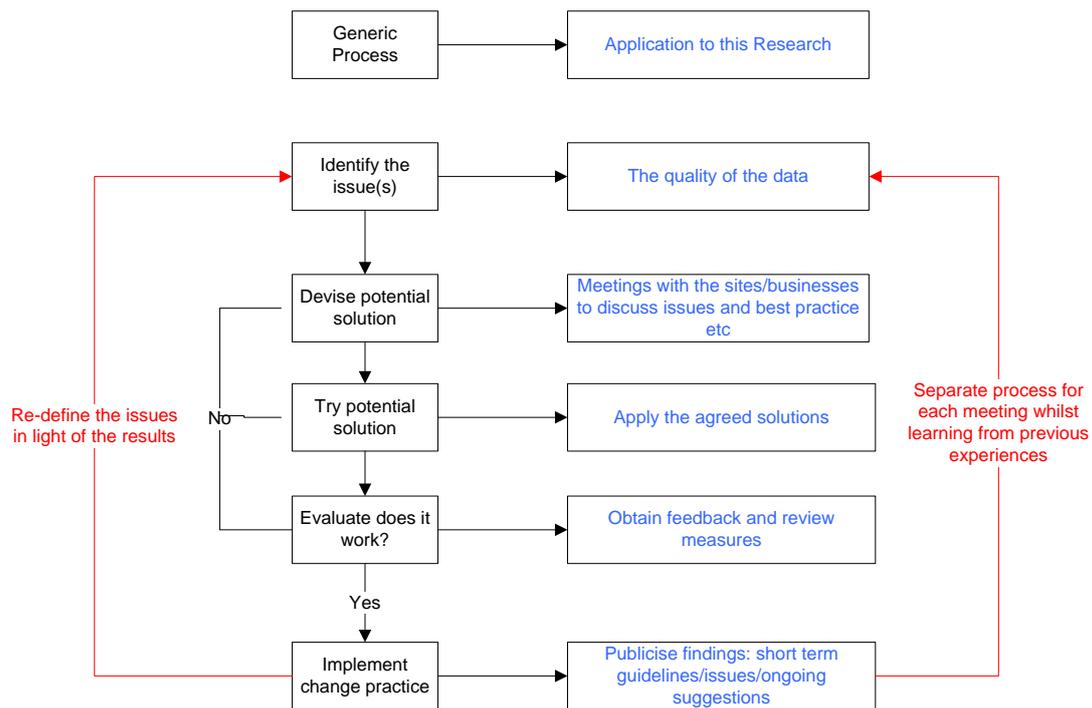
Figure 7 Applied model of action research for Remploy

Based upon McNiff (2002: 7, 11-12)

The practical application of this model is detailed within Sections 11 and 12

As highlighted within Section 8 this qualitative study had a distinct practical origin relating to the re-launch of Remploy's data quality initiative following the completion of the initial phase of the Modernisation Programme which saw a rapid decline in the overall quality of the data as measured by the Data Accuracy KPIs.

One of the main aims of this project has been the attempt to highlight the importance of getting the data right first time by the application of root cause analysis and correction of data errors at source. The qualitative study was viewed very much as a two-way education and learning process by which the site and business teams would be able to become more acquainted with the data quality initiative and all that entailed, but even more importantly be able to provide rich feed back, utilising the concepts of collaborative action research (Miles and Huberman 1994:9). It was intended that this would enable best practices to be developed and communicated, important issues and problems to be identified and solutions worked upon, along with the development of longer term principles and guidelines.

Internal Quantitative Survey

The quantitative survey, in the form of a self-administered web-based questionnaire was distributed to the one hundred and eleven recipients of the Data Accuracy KPI reports during the summer of 2009 using NTU's own survey tool Autoform. This was viewed as an essential development of the overall data quality initiative not just as a follow-up to the site visits, but to complement this process, as a further means of measuring peoples' views and perceptions of the quality of *their* data and to gain additional valuable insight from all levels of the organisation. The cultural climate was also seen as appropriate. Just as one chose to carry out an external quantitative survey for Document Four during the run up to the Modernisation Programme, the post Modernisation period was seen as ideally suited to a re-appraisal of those important ideals and concepts of which data quality was viewed an essential element.

Each of the two research processes is described in detail within forthcoming sections, however prior to undertaking any form of research, one has to be mindful at all times of the ethical implications of the researcher's actions. The next section discusses this topic in detail with particular reference to the research carried out as part of this study.

10. ETHICAL ASPECTS OF THIS STUDY

Remploy's Ethical Standards

The main research undertaken for this document has been carried out with the author's own organisation. Remploy has developed a code of moral practice allied to its five key values, which guides the organisation's very existence and dictates its moral climate, without which it would find it impossible to operate. These values of Professionalism, Passion, Respect, Openness and Keeping Promises, again echo the moral principles of total openness, honesty, respect for others and integrity. Within the context of Remploy, the author has executive approval to undertake this project and has been a member of the organisation for over sixteen years working closely within all aspects of the business, not only within Finance and IT. This enabled the researcher to build up a network of colleagues over a number of years, gaining their respect and support which has assisted considerably in gaining access and facilitating the qualitative and quantitative research detailed here. The Company's values and associated culture, together with the enduring relationship one has developed with both the Company and one's colleagues helped formulate the ethical principles employed throughout this entire research. One has then been able to build upon these professional relationships, a number of which were able to set up further contacts within their own individual areas. It was recognised however that this places even greater pressure on maintaining those moral principle of total openness, honesty, respect for others and integrity not only to maintain one's own moral and ethical integrity and reputation, but to ensure that none of the supportive colleagues were let down.

There are a number of generic ethical guidelines that relate to all forms of research, in particular, adherence to legal requirements including the Data Protection Act, organisational procedures, confidentiality and anonymity, the keeping of promises together with the obtaining of permission to publish. From previous research, certain key moral values and principles emerged which can be applied equally to both business and life ethics. The detailed code of practice published by the Economic and Social Research Council within its Research Ethics Framework Economic and Social Research Council (2006), encapsulates a great deal of the literature on the subject. It constitutes a set of minimum generic standards which encourage good ethical practice in social science research encapsulated within certain key principles in that the research should be designed, reviewed and undertaken to ensure integrity and quality.

This section will focus and evaluate those ethical elements which appertain directly to the research undertaken as part of this project. This area of investigation embraces both the practical challenges of undertaking this specific research together with a review of the related literature. The intention is to identify the principles that should be followed and also in more detail the implications and challenges that have emerged.

Security

The questions of confidentiality and anonymity have been highlighted, which then leads onto a discussion as to how these elements may be controlled. The issue is not just about the researcher ensuring that research details are not disclosed directly to other parties for example by word of mouth, but heavily involves the matter of data security and its storage in either hard copy or electronic format. The author ensured that only summary data was being kept as a hard copy without any direct reference to any research contributor. The exception to this is where an individual is referred to within any of the six documents (other than as a published literature reference), but this is only made with the explicit authority of the person quoted and is used in support of a particular relevant position or stance. Some of the detailed information containing direct references to individuals, was gathered from face to face meetings and written down, but this data will not be retained as a hard copy, but committed to electronic applications such as Word or Excel. The original material will be disposed of securely (using Remploy's document disposal service) after the completion of this research.

Electronic Security

The questions of security around the various electronic formats pose far more complex problems. The entire data is held on the author's own company laptop, essentially in Word, Visio, SPSS and Excel files secured by special encryption software. This data is also stored upon a back-up media within the Remploy IS network as part of the company's back-up and disaster recover policy and procedure. Detailed person-sensitive data is also held externally on NTU's web based survey tool Autoform which has been used to carry out two electronic questionnaires. Satisfactory evidence has been obtained to indicate that the data held within the Remploy network and NTU's Autoform environment, meets acceptable storage and access requirements to provide adequate security.

Ethical Aspects of Qualitative Research Relating to this Study

Action research relies upon total openness amongst the participants with the respondents in particular feeling able to make a contribution without fear of any repercussions. Likewise the researcher must ensure that no one is ever placed in a position where this is likely to occur. Each site visit was designed to both provide information and gather data by enabling open discussion to take place within a positive blame free environment with each party able to share thoughts and ideas around a common goal. The researcher also tried to ensure that the respondents were revealing their own opinions and not those which they thought that should be given. In line with this policy of openness, all the notes taken by the author at each meeting were circulated to all participants in bullet point form with a request for confirmation and feedback.

Gill and Johnson (2002: 93-94) referred to certain ethical issues relating to action research including the acceptability of the client/project to the researcher, the values relating to the parties and the confidentiality and the protection of respondents. They further identified that there may be circumstances where respondents wish to remain anonymous which in practice may prove very difficult, in addition some business may be happy to be identified in any subsequent publications whilst others may require anonymity. Miles and Huberman (1994: 290-297) identified certain specific ethical issues surrounding qualitative research: the worthiness or value of the project; the competency and expertise of the researchers; obtaining informed consent; the benefits/costs trade-off; potential harm and risk; trust and honesty; privacy, confidentiality and anonymity; research quality and integrity; and the use and miss-use of the results and potential conflicts, dilemmas and trade-offs. The author is aware of these issues and concerns but feels that these potential problems were not present within the study. In many cases an invitation came directly from the businesses and throughout the proceedings there appeared to be no evidence of any negative attitudes or consequences.

Ethical Aspects of Quantitative Research Relating to this Study

Gill and Johnson (2002: 121) discussed the circumstances of survey research conducted within a single organisation commissioned by an interested party. The salient points recognised that, consultation should take place as to the purpose of the survey, with the opportunity for fellow colleagues to have input into the survey design, together with an acknowledgement that the results could have implications for all concerned. All these points were accepted and taken into consideration within this study.

The use of internet-based research compared with the more traditional modes of communication brings with it certain concerns. Nosek, Banaji and Greenwald 2002) identified ethical issues relating to the absence of the researcher, potential exposure of confidential data and/or identity to a third party and lack of detailed de-briefing facilities. They also highlighted related security questions surrounding confidentiality and anonymity, security of data transmission and data storage, the tracking of participants over a period of time and the possibility of miss-behaviour by participants, intentional or otherwise. These issues are all well founded but have been dealt with earlier within this section.

Having established the ethical principles governing the research for this thesis, the following section describes the qualitative research process that was employed.

11. INTERNAL QUALITATIVE STUDY

The qualitative research for this document has been built upon the experiences and lessons learnt from the research carried out within Document Three. This involved the use of focus groups in conjunction with an action research approach utilising process mapping, to collect data around processes and procedures within Remploy's operational and manufacturing environment. This was aimed at obtaining a better understanding of the data flows and assist in deriving a greater appreciation of the data as it interacts with people within the relevant processes. The qualitative element of the research for this document took the format of a series of discussion-type focus group meetings sharing experiences, ideas, issues, problems, successes, around a basic flexible agenda, whilst still employing an action research approach. This approach was less formal excluding the use of process mapping as the main intention was to generate discussion and interaction to discover peoples' real feelings and attitudes towards *their* data. Such "local qualitative research may provide better tools for drawing out intricacies…opening up new understandings of novel and emerging phenomena" (Pollock and Williams 2008:110).This section places this interactive process of data collection, within the overall context of focus group and action research, whilst relating the direction of the meeting agenda to previous discussions within this study.

As stated previously, the researcher decided that a re-launch of the data quality improvement initiative was necessary and this would be best achieved by working together with those colleagues who were actively undertaking the vital 'customer order receipt……to final payment' processes, at factory and business office levels. At the outset there was not a specific plan in place to visit the majority of factories, but to concentrate initially on around a dozen. These were intended to be a mixture of those that were viewed to have performed well during the initial two years and those that had performed less well, in an attempt to ascertain the factors behind the variations in performance as well as to reinvigorate the entire initiative and instil a degree of sustainability. Also after attempting to engage the businesses from a 'top-down' perspective, it became apparent that more balanced method involving a 'bottom-up' approach would prove more beneficial. This was also seen as a key factor in part to overcome instances in a number of the businesses where it was claimed that the 'message' had never been cascaded down to all levels. There was also a realisation that this was the 'right thing to do', in that it provided an opportunity to engage with those individuals who acted as the 'data producers', 'data custodians' and 'data consumers', to promote the whole ideal of data quality and obtain their views, input and feedback into the overall concept of data quality and its sustainability. These practical aspects dictated the nature of the qualitative research for this document, but to complement this, the recognition of theoretical and academic research principles helped to enrich the overall outcomes. This is a further example of the congruity between theory and practice

Focus/Discussion Groups

It was decided to eschew the more formal focus group/process mapping approach, used in Document Three, in favour of a more informal process engaging those individuals who where actually responsible for the factory and business processes. Remploy is essentially a mini conglomerate and whilst not every location is identical, in size or complexity, the basic functions of production, purchasing, sales and administration exist in varying degrees in all sites and the representatives covering each of these functions together with the relevant management and/or supervisory personnel were the obvious colleagues to involve. It was felt that a more informal atmosphere would generate a more relaxed environment to enable more free and frank discussions to take place, although it was acknowledged that this would depend greatly upon the mood and tone set by both the researcher and the local management team (Pearce 1998: 72).

Whilst an informal discussion approach was considered the most appropriate, one must not lose sight of the fact that these 'inter-active engagements' were conducted within a focus group type environment, in the form of free flowing open discussion on a focussed topic Bryman and Bell (2003: 368, 570); Fisher (2004: 45), attempting to 'tease' out facts and information from the participants to construct meaning (Bryman and Bell 2003: 371). Within a well constituted focus group, participants are able to discuss issues and topics that are important and significant to them, whilst engaging in an open dialogue where each can share, argue and challenge each other's views (Bryman and Bell 2003: 369). Such an environment can assist individuals to define their issues and problems and work together to identify and apply potential solutions (Bryman and Bell 2003: 369).In this way focus groups can help group norms and cultural values, encourage open conversation, facilitate the expression of ideas end experiences, encouraging participants to generate and explore their own questions and experiences, by tapping into a wider form of understanding (Kitzinger 1995: 302). Focus groups are sometimes criticised because of the unsystematic nature of the sampling process and the potential difficulties of replicability and reliability (Bryman and Bell 2003: 371). However in this study, this approach is seen as both a strength and an advantage, because the resultant participation and unpredictability of the outcomes, particularly where strong personal interaction takes place, was the most appropriate method for this particular topic (Eden and Huxham 1996:82).

The Data Capture Process

The data capture process took the form of a series of face to face meetings carried out at a number of the Company's factories and business offices, supplemented by conference calls used where either sheer distance or time precluded a physical meeting. The meetings were arranged in a number of ways; by the author contacting individual sites, upon the receipt of an

invitation from a site, or a number of visits organised via a member of a business management team. As the process developed the majority of the further meetings were requested either by individual sites or by a site-owner business. A generic agenda was developed to focus each event and identify the main points of discussion, whilst still being flexible enough to tease out any other relevant issues. These agenda points embraced:

- Discussion on the overall Corporate Data Quality Improvement Initiative with particular regards to the Data Accuracy KPIs and the way in which these support the overall process
- Implications for the site and business
- The Site/Business KPIs
- Priority areas
- Short term actions
- Medium term approach
- Ensuring that everyone is aware of the implications of their actions and responsibilities
- Any further relevant points

This generic agenda encapsulates also the recurring themes around *Processes* and *People*, together with the Cultural/Organisational themes relating to measurement and reporting, communication, change management and short and long term priorities, identified from the review of the literature as detailed in Table 2 on pages 50-52.

As stated the initial plan when commencing this study was to cover around a dozen sites, but it became apparent immediately from the outset, that there was a distinct appetite, across all levels within the manufacturing businesses, for better quality data as sites and businesses rapidly requested a visit. This gathered a momentum, which led one to decide to expand the initiative to encompass as many sites as possible. This valuable additional access has not only widened the improvement process within the organisation, but has expanded the researcher's insight, to further identify understanding around this subject.

Every effort was made to ensure that this was not viewed as 'a visit from Head Office' or as just another training session, but as a two-way information exchange. Notes were taken by the researcher and were then written up in bullet point form, usually within twenty four hours, to a predetermined format and circulated to all attendees for their comments and feedback. These outcomes were then analysed and the findings generated as lessons learnt and to be learnt, reproduced in the form of key findings, short term guidelines, issues and ongoing suggestions for improvement as described in the following section.

12. QUALITATIVE STUDY- ANALYSIS AND FINDINGS

This section summarises the actual research process, analyses the results from this research, identifies related key findings and then proceeds to provide guidelines as to best practice, recognising certain issues and problems and finally offers suggestions for future progress.

The Research Process

The main thrust of the process took place between December 2008 and April 2009. In all, forty eight of the fifty four factories and seven business operations and sales teams were covered. Thirty four separate locations were actually visited, a number of these events comprised representatives from two or more factories in the form of regional cluster meetings, to speed up the process, reduce travelling and share experiences. In addition three conference call meetings were also held where it was not possible to arrange for all the participants to be together at the same time. Four of the factories also received a second visit after a specific request. Over this time the author travelled almost eight thousand miles. The process is summarised below in Tables 3 and 4:

Analysis of the meetings

Meetings covered by:	Site Visit	Joint Meeting	Conference Call	Total
Factories	30	12	6	48
Operations Teams	4		2	6
Sales Teams		1		1
Additional meetings	3		1	4
Total	37	13	9	59

Table 3 Analysis of the meetings

Timescale of the meetings

Oct 08	Dec 08	Jan 09	Feb 09	Mar 09	Apr 09	Sep 09	Total
1	13	18	3	15	8	1	59

Table 4 Timescale of the meetings

The number of attendees at each meeting (excluding the researcher) varied between one and six in respect of the pure site factory visits and up to nine in the case of business operations/sales meetings. There was also quite a breadth of job roles represented, from sales, procurement, finance, administration and well as operations and in total in excess of 130 people took part.

Every attempt was made to include all participants in the discussions whenever possible, although there were occasions where some attendees' natural reticence may have prevented them from participating fully. In these circumstances one had to reply upon the local manager and other colleagues to compensate. The ability of the researcher to gain full access to such a wide and diverse contact base added considerably to the overall richness of this research. This is reflected not only in the volume of the sites covered and people interviewed, but also the extent to which virtually everyone appeared eager to participate fully and attempt to make a contribution. The overall feedback proved to be very positive and one did not detect any real degree of negativity. Some very interesting comments emerged particularly relating to the roll out of the Data Accuracy KPIs themselves. A number of managers and their staff stated that they had never previously been aware of their existence. This immediately brought into question the method by which this and other initiatives had been implemented, raising uncertainty as to the quality and effectiveness of employing purely internal top-down communication processes.

Analysis

The initial meetings followed the basic format of the generic agenda described above, but additional related priorities quickly began to emerge alongside the original aim of re-launching the data quality initiative, on the back of re-focussing attention onto the Data Accuracy KPIs. The wider perspective emerging from the research, with regard to sustainability, became a real objective, mirroring the progression of this entire study. Whilst the term 'sustainability' was only mentioned briefly, discussions revolved around; 'what data quality means', 'why it is so important?', 'how the KPIs fit in with and contribute towards this concept', 'what has gone well and what has gone poorly in relation to this?', 'what are your problems and issues?', 'what are your suggestions for improving things?', 'how can each factory and business make a considerable contribution towards improving data quality?'. It was also recognised that four of the seven KPIs were within the direct control of each factory but the remaining three required input from other sources both internal and external to the Company. The format of the discussion evolved to encompass:

- Re-focussing the Data Accuracy KPIs within the perspective of the overall data quality landscape
- Identifying and highlighting good and bad practice

- Identifying issues and problems
- Developing best practices within both the short and medium terms
- Determining how best this may be implemented
- Leaning from the above to improve on-going practice- (Action Research/Learning)

The discussions were captured and recorded by the researcher in bullet point form and circulated around all attendees as soon as possible after each event. Feedback was requested and any resultant comments were noted and added where applicable. In all thirty seven separate events were recorded in this way. This process generated two hundred and fourteen points of discussion, a number of which were repeated on several occasions as one would imagine.

These principle themes noted from each meeting, were then analysed further within Framework 1- Appendix 1a.
The data was arranged in columnar form analysed by:

- Site/Department   ) Although for the purposes of this document
- Business   ) individual personal, site and business information
- Date of the meeting   ) has been excluded to preserve anonymity
- The detailed agreed discussion points relating to each site/business meeting

The discussion points were then analysed into five major categories colour coded to aid identification:

- Current actions and policies- The way we are doing things currently
- Issues and problems- Issues and problems identified
- Actions to be taken going forward- What we are going to do in the short and medium term
- Current culture- Current inherent thinking, attitudes and behaviours
- Future culture- Intended inherent thinking, attitudes and behaviours

These categories were chosen to reflect the nature of the action research approach employed, in that a review of the current actions and policies would help to recognise both the good and poor practices, from which the issues and problems could be identified, leading to actions going forward to promote and further embed better practices across the entire business in a form of action learning. Current cultural and behavioural issues were examined to determine whether they were enablers or restrictors, to be developed or eliminated and thereby assist in developing future positive cultural practices to facilitate ongoing progress.

Framework 2- Appendix 1b then proceeded to consolidate the discussion points within each separate category and in the case of the current culture and current actions and policies,

classified further as being identified as a positive (+) or a negative (-) influence. Table 5 below summarises the results.

	Current Culture	Current Actions and Policies	Issues and Problems	Actions Going Forward	Future Culture	Total
Total	27	25	52	82	11	214
Positive	19	23				
Negative	8	2				

Table 5 Framework 2

Both Framework 1 and 2 were developed to consolidate all the various conversational strands in an attempt to identify related topics and ideas. From the outset certain important notions and impressions emerged from the discussions and this analysis and these were subsequently developed as key findings. It was felt that these fell in three broad categories relating to: *lessons learnt* that should be put in practice at all sites, involving basic quality management principles, ownership, responsibility and support, together with measurement and reporting; positive personal *motivational factors* which help to engender commitment from individuals, relating to internal competition and targets, an acceptance of best practices and how these relate to one's ideas and principles; together with organisational; and cultural *environmental elements* essentially involving leadership and management issues. A detailed analysis of these key research findings appear in Appendix 2A. These generic findings will be discussed further within Section 16, as part of the consolidated review of the research outcomes.

Recommendations for Action

At the end of March 2009, with 85% of the meetings completed, a detailed appraisal of the whole procedure was carried out, taking into consideration the meeting process, the discussions that ensued and their subsequent analysis in Frameworks 1 and 2, the key findings, together with a review of the performance of the Data Accuracy KPI Index during the period of this qualitative study. A number of guidelines, issues and suggestions for future best practice were distilled from the evidence of these deliberations. The researcher decided that it was important to communicate the salient action points emanating from the meetings, to re-enforce ongoing practices, provide guidance towards optimising processes and procedures and to identify problems to be resolved. In addition it also provided all participants with evidence that the information sharing process was real and that everyone's contribution was considered important and had received due attention.

In line with this consideration, on 30th March 2009 a report was circulated to all recipients of the monthly Data Accuracy KPIs, comprising suggested short term action guidelines which could be applied to bring about immediate improvements, the identification of issues and problems which need to be addressed, together with longer term improvement initiatives of a more cultural element. This data quality improvement report is detailed in Table 6 below.

Data Quality Improvement Initiative Report

After covering over 80% of the factories and business offices it will be beneficial to share briefly, experiences, examples of good practice and issues which have been identified, to assist us in embedding these improvements to achieve sustainability and getting 'it' right first time.

Long term improvement is down basically to the processes and the training and development of people and as these improve then the index will take care of itself. The index reflects the quality of these elements. We can learn from this corrective process and gain an understanding of the reasons behind the issues and problems and their ultimate resolutions, so as to aid future progress. In this way it can become self sustaining and not merely a cleaning up exercise.

Short Term Guidelines

- Hold a review/planning meeting at least once a week, print off the Index and supporting detailed reports from cyberquery and review overdue items with the members of the team. In this way the reports can also act as an expeditor to identify late receipts and deliveries. Ensure there is adequate cyberquery access
- Provide visibility of the measures and monitor progress over time
- Focus initially on the four key site-specific elements of- Goods Despatched Not Yet Invoiced and overdue production, purchase and sales orders. If necessary generate action plans with target dates
- Review Receipts Not Yet Invoiced but with particular regard to returns. There does not appear to be any formal process within the Company to ensure that purchase returns, whether goods or services, are either:
  - Off-set against a compensating receipt where is this is a corrective action
  - Matched against a credit note from the supplier. There are many items of considerable value months or even years old which may necessitate write-offs
- Ensure that orders are dated with the anticipated receipt/manufactured/despatch date and not the default date which is 'today' which will automatically make them overdue the following day.

- Rather than raise single production orders for large volumes covering a long time period, set up orders for smaller quantities with shorter lead times
- Hold monthly conference calls with each business's Op Team to monitor progress and issues

Issues

- There are training requirements and gaps in people's knowledge especially following Modernisation
- The 'Super User' concept not yet followed up fully
- Some sites have no identified business-specific ISBM and have problems obtaining assistance
- Liaison with SSC
- Problems identified in accounting for carriage charges on suppliers' invoices

Ongoing Suggestions

- Need to ensure everyone is fully aware of the implications of their actions
- Better understanding of the underlying principles and requirements
- Ascertain root causes of issues and problems
- Appreciation as to how the KPIs fit within the corporate data and information quality initiative
- Identify the personnel dealing with each type of order and agree who does what with responsibilities for each process
- Build data quality targets into people's objectives

Table 6 The data quality improvement report

The guidelines, issues and suggestions where intended not just to provide feedback, but to focus peoples' attention upon the salient outcomes of the series of meetings, together with the findings from the literature reviews, to identify the actions that were happening and/or should happen to drive the data quality initiate forward in the future. The discussion on the performance of the Data Accuracy KPI Index within the next section substantiates this.

The Wider Context of this Research

It is appreciated that this study has been carried out entirely within a work-based setting therefore it is important that this is then positioned within the overall context of this research project and the broader issues and concerns that emanate from this, for both practice and theory. In line with this, the organisational-specific short term guidelines, issues and ongoing

suggestions described above have been translated into a format that will enable them to be better applied within a wider environment and these are analysed in detail within Appendix 2.B. These generic findings will be discussed further within Section16, as part of the consolidated review of the research outcomes.

The paramount importance of measurement, reporting and feedback has been stressed throughout this thesis. The following section traces the performance of the Data Accuracy KPI Index over its lifetime from September 2006 to November 2009 and in particular to the period between November 2008 to November 2009, to identify whether there is any correlation between the data quality activities undertaken within this study and the performance of the Index.

13. THE DATA ACCURACY KPI INDEX PERFORMANCE REVIEW

The importance of measurement, analysis, reporting and feedback has been emphasised continually throughout this entire research. Whilst the KPI Index represents a composite view of a what is basically transactional data, there is a strong argument to suggest that it is also indicative of the quality of the data overall and the progress being made towards its continual improvement. The following discussion traces the performance of the Index overall and in particular the period following the commencement of the site visit programme described in the preceding section, to determine whether there is any correlated sustained improvement.

Period of Review- September 2006 to November 2009

This section reviews the Index's performance over this period, analysing the fluctuations, variations and trends and examines the impact of the various external influences both positive and negative. It then attempts to attribute relevant meaning. It was felt that allowing a period of just over six months to elapse from the end of the site visit programme, would permit a degree of maturity to take place and thereby enable a more objective appraisal to be undertaken. Full details of the Index mechanism and the methodology used to roll out the process across the Company, have already been outlined in Section 8.

Table 7 below tracks the movement of the total overall Company Index figure by quarter over the designated period. Columns one and two identify each quarter; column three represents each financial year's (April to March) cumulative percentage movement by quarter; column four represents the quarterly improvements (+/-) in terms of an index with a September 2006 base date; column five presents each quarter in terms of its cumulative percentage improvement derived from column four; whilst column six displays the overall trend.

Data Accuracy KPI Index Improvement Tracker

	Qtr/Yr	Annual Cum Impr %	Moving Index	Index Impr	Trend
06/07	Sep-06		100	0%	0%
	Dec-06	3%	97	3%	4%
	Mar-07	29%	71	29%	8%
07/08	Jun-07	3%	69	31%	12%
	Sep-07	6%	67	33%	16%
	Dec-07	-9%	77	23%	20%
	Mar-08	16%	60	40%	24%
08/09	Jun-08	-15%	69	31%	28%
	Sep-08	-27%	76	24%	32%
	Dec-08	-15%	69	31%	36%
	Mar-09	6%	56	44%	40%
09/10	Jun-09	6%	53	47%	44%
	Sep-09	6%	53	47%	48%
	Nov--09	14%	48	52%	52%

Table 7 Data Accuracy KPI improvement tracker

The data within Table 7 is also depicted below in graphical form in Figure 8 below
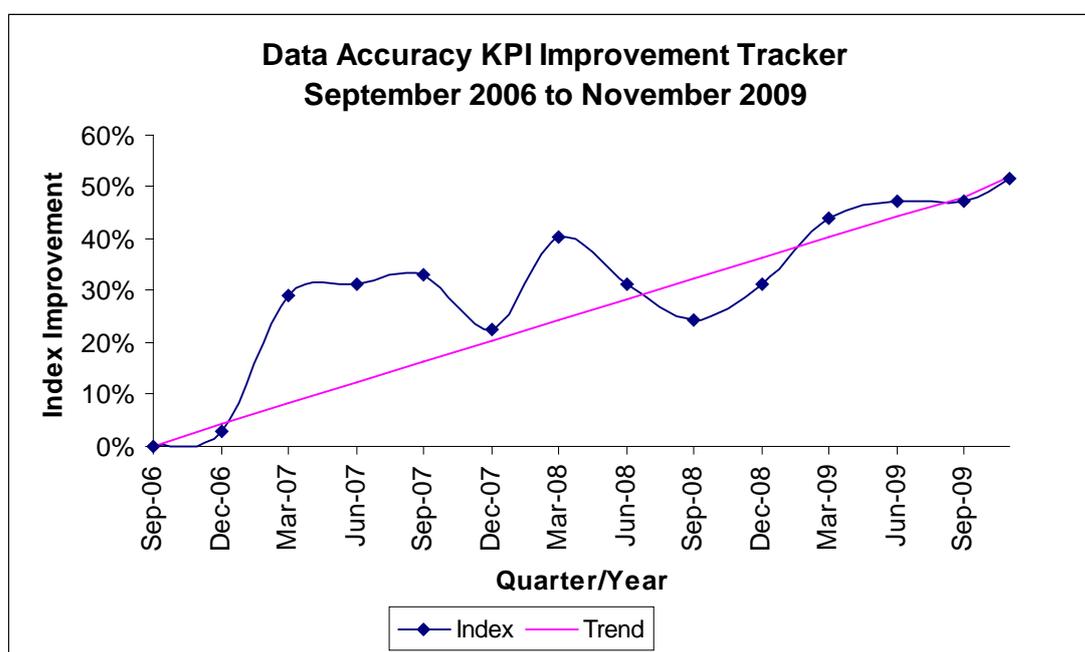
Figure 8 Data accuracy improvement

The improvement tracker was developed as a means of highlighting the periodical movements in the Index on a companywide basis to identify improvements or otherwise and indicate any trends. In this way it was intended to measure the momentum of any improvements to determine whether there was any degree of sustainability in the manner discussed in Section 2 on page 26. The figures were based upon the aggregated monthly company index at each quarter end. A quarterly measurement was considered to be preferable in that it provided a better perspective of the overall trend(s) than a more complex monthly measurement. The tracker being the aggregation of all the site and business indices provided a corporate summary of what was actually happening across the businesses

A summary of the progress:

- 29% improvement in the first six months to March 2007
- 33% improvement in the first year to September 2007
- 16% improvement in the year to March 2008
- 40% improvement in the first eighteen months to March 2008
- 27% decline in the eight months to November 2008- which coincided with the Company's Modernisation Programme
- 37% improvement in the year to November 2009
- 52% improvement between September 2006 and November 2009

The initial eighteen month period to March 2008 saw significant improvements (40%), as one would imagine with any new major initiative, especially as there was plenty of opportunity for early 'quick wins' coupled with executive support and constant monitoring and reporting. The above graph also highlights a 'glitch' within this period, in December 2007, which appears to be a seasonal issue, related to Christmas and New Year, as there was a similar occurrence in the preceding year. It is recognised that there will always be fluctuations within any index and that the real measurement of any significance is the overall 'trend'. The steep decline from April 2008 may be attributable solely to the effects of the Company's Modernisation Programme which saw a third of the factories closed, businesses re-positioned, certain employees transferred to new locations, with others leaving the business. The period from March 2008 to September 2008 was certainly a huge hiatus to 'business as usual', as a considerable part of the business re-focussed itself onto more short term pressing issues. Whilst the Modernisation Programme achieved all of its objectives within timescales and budget, there were short term negative impacts which affected certain activities, the Data Quality Initiative amongst them. One accepts this as a matter of course, having been directly involved in the financial aspects of the planning, budgeting and control of the Modernisation Programme. However after the completion of this final phase during the autumn of 2008 it was necessary to undertake the re-launch of the Data Quality Initiative which led ultimately to the qualitative research described in the previous section.

The direct outcomes of the factory and business meetings have already been described and recommendations made for future short and medium term practice. However within this context one has to validate such findings to ensure that they are not mere rhetoric, but have real substance. Table 8 below charts the activity carried out as part of the factory and business programme, superimposed upon the Data Accuracy KPI Index between November 2008 and November 2009 in both month upon month and cumulative format. During this period, quarterly business targets were set in December 2008 and the reporting was also extended to factory and site managers in January 2009, each with the potential to generate additional positive influences.

	Nov 08	Dec 08	Jan 09	Feb 09	Mar 09	Apr 09	May 09	Jun 09	Jul 09	Aug 09	Sep 09	Oct 09	Nov 09
No of Meetings	0	13	18	3	15	8	0	0	0	0	1	0	0
Index Impr % Month	0	9%	7%	-4%	16%	1%	1%	5%	0	2%	-3%	7%	2%
Index Impr % Cum	0	9%	15%	12%	26%	27%	27%	31%	31%	32%	30%	35%	37%

Table 8 Data Accuracy KPI monthly performance

From analysing the above table, it is evident that there was a significant improvement in the Index (27%), following the commencement of the factory and business meeting programme from December to April, in line with the number of meetings carried out. However within this context it also has to be appreciated that in the two preceding years, there had also been considerable improvements during the period from December to March (26% in 2007 and 22% in 2008). That fact is accepted, but it also has to be recognised that as year upon year improvements take place, the scope for further significant improvements become more and more difficult unless a sea change approach is introduced.

In an attempt to ascertain whether any degree of sustainability had taken place within the businesses themselves, it was decided that from April 2009 onwards, the only 'Central' activity would be the publication of the Index reports on a monthly basis. During the summer of 2009 there was a levelling of the rate of improvement, but overall it still remained positive. However during September there was a 3% decline on the August figure and when the Index was measured again part way though October (13th), a further 7% decline had taken place during the preceding two weeks, leading to a year to date 1% reduction overall based upon March 2009. This situation was raised immediately as a high priority matter across the businesses and the support of the Executive Team was enlisted. Two weeks later at the end of October the position had changed dramatically so much so that the 7% decline had transformed to a 7% improvement, which has further enhanced in November by 2% to register an over all 37% improvement in the twelve month period to November, with an overall 52% improvement since the commencement of the entire initiative just over three years previously. There was strong evidence to suggest that whilst a degree of sustainability appeared to be in place as indicated by the overall trend in the KPI tracker, it did not appear to be self-sustaining in that it required the regular involvement of external agencies such as senior management and the constant attention of the project leader to maintain the momentum.

Subsequent Events

Further evidence of the weight and richness of this argument is demonstrated when one examines the performance of the Index over the succeeding four months (December 2009 to March 2010). The first three months indicated seasonal fluctuations in line with the experiences of previous years, followed by a recovery in March to record a 22% year on year improvement, promoting the overall improvement since September 2006 to rise to 56%. This performance is entirely consistent with previous trends contributing further to these findings.

Summary of the Findings

There is considerable evidence to suggest that the progress and improvement described above have real significance leading one to believe that there is potential for real cultural change to take place if improvement initiatives are managed correctly.

This has implications for the wider context of this research as seen by the evolution of the measurement and reporting process which may best be summarised as:

- "What gets measured gets done"
    - A good start, but by whom?
    To:
- What gets measured by the Exec gets done quicker"
    - "A further improvement, but too top-down
    Leading finally to:
- "What is measured, communicated, discussed and agreed at all levels has a very good chance of becoming embedded"
    - Bottom-up supported by top-down
    - A potential key to sustaining any kind of change?

There is considerable evidence to claim that any improvement initiative cannot be undertaken in isolation and that everyone needs to become involved. There is also however a caveat, in that at this stage it appears that the level of progress achieved appears to be commensurate with the levels of activity of the internal champions or change leaders, suggesting a climate of 'controlled sustainability' rather than 'self sustainability'. This may be a reflection of the relevant infancy of the overall initiative. This question of time, age and 'maturity' is seen as being important in a number of the areas relating to this research and will be discussed within the concluding section together with the involvement of champions at every level.

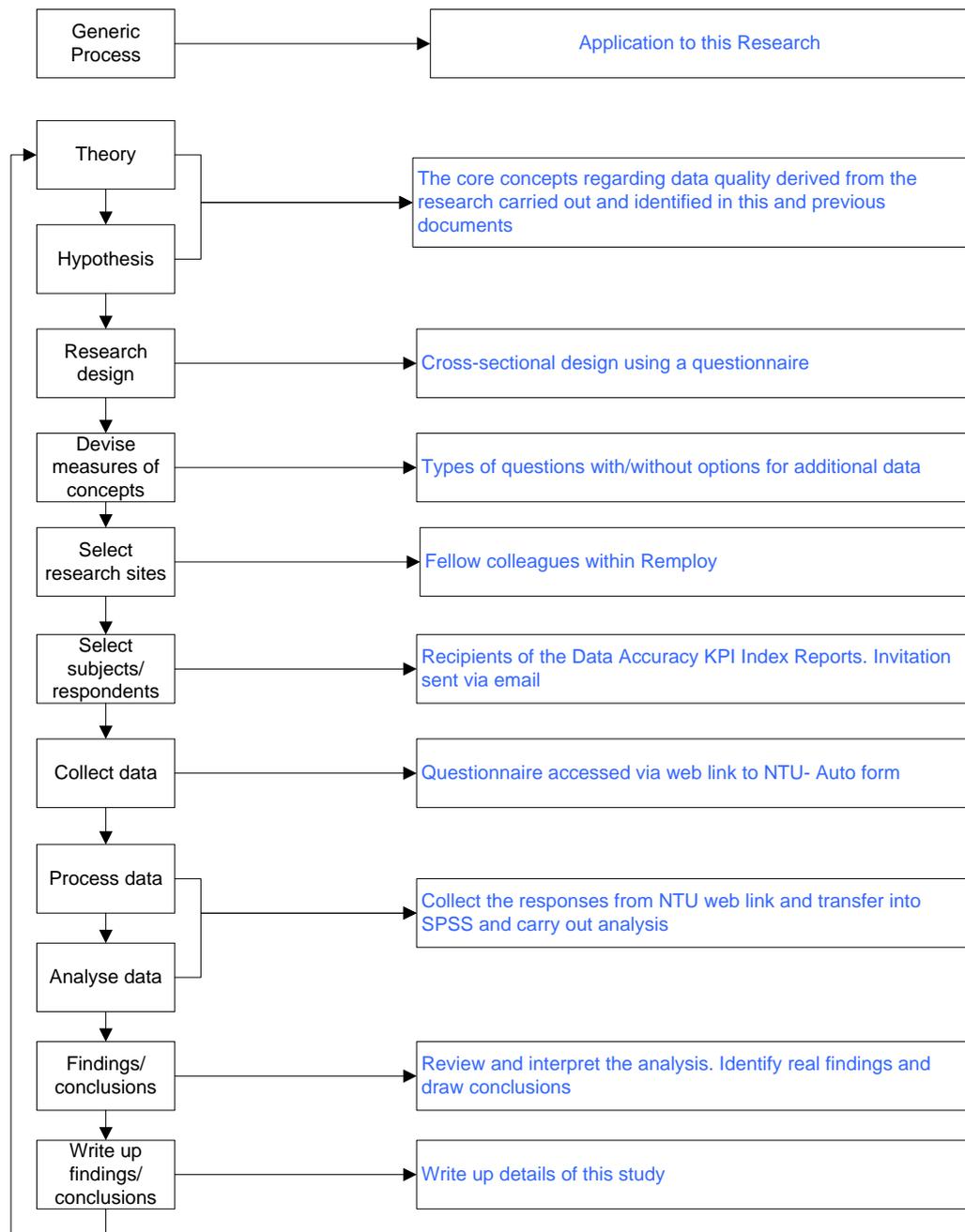The above findings are reproduced in Appendix 2.C and will also be discussed further within Section16, as part of the consolidated review of the research outcomes.

To supplement the qualitative study and to attempt to determine the attitudes and perceptions of one's colleagues towards data quality, a web-based survey was carried out during the summer of 2009 as described in the following section.

14. INTERNAL QUANTITATIVE SURVEY

To build upon the progress made within the Data Quality Improvement Programme, a web-based survey was carried out during the summer of 2009 amongst fellow Remploy colleagues as a means of determining their views, attitudes, thoughts, feelings and opinions with regard to data quality in general, their perceptions as to the quality of *their* data in particular and their potential commitment towards continuous data quality improvement. Coming immediately after the site and business meetings described above, it was felt that this would also complement this initiative and emphasise that the site meeting programme was not a one-off exercise, but part of a much wider and far-reaching agenda. The process employed is described within this section.

Although the quantitative research undertaken during Document Four experienced a low response rate, the process appeared to function effectively, therefore it was decided to follow this same research mode that of a survey based self-administered questionnaire distributed on this occasion to certain fellow Remploy colleagues, using NTU's web-based on-line survey tool Autoform. This mechanism allows researchers to generate a survey questionnaire and collect and collate the resultant data which is then made available via email. The subsequent analysis was undertaken using the SPSS statistical analysis package provided by NTU. The nature of quantitative research may be characterised as a linear progression commencing with a theory and then working through to the ultimate findings and conclusions. Bryman and Bell (2003: 89) provided a very useful generic process blueprint (in black), which has been adapted to fit the context of this internally based survey (in blue), depicted in Figure 9 below. Each element of the initial generic process has been linked to the relevant step within the research cycle for this document to indicate visually how the entire process has been undertaken. The initial elements of Theory and Hypothesis have been derived from previous discussion and research conducted with in this and previous documents. The next five elements relating to the construction, publication and distribution of the survey are described in detail within this section, whilst the latter four elements covering the processing and analysis of the data and the subsequent findings are detailed within Section 15.

Generic Process	→	Application to this Research
Theory		The core concepts regarding data quality derived from the research carried out and identified in this and previous documents
Hypothesis		
Research design	→	Cross-sectional design using a questionnaire
Devise measures of concepts	→	Types of questions with/without options for additional data
Select research sites	→	Fellow colleagues within Remploy
Select subjects/ respondents	→	Recipients of the Data Accuracy KPI Index Reports. Invitation sent via email
Collect data	→	Questionnaire accessed via web link to NTU- Auto form
Process data		Collect the responses from NTU web link and transfer into SPSS and carry out analysis
Analyse data		
Findings/ conclusions	→	Review and interpret the analysis. Identify real findings and draw conclusions
Write up findings/ conclusions	→	Write up details of this study

Figure 9. The quantitative research process

Adapted from Bryman and Bell (2003: 69)

Bryman and Bell (2003: 573) defined a questionnaire as a collection of questions administered to respondents; but when employed without the direct interface of the researcher, it is termed a self-completion questionnaire The main objectives in designing a questionnaire are to maximise the proportion of subjects answering the questionnaire i.e. the response rate and to obtain accurate relevant information for the survey (Wai-Ching 2006). Oppenheim (1992: 7-8) emphasised the importance of adequate preparation and planning

prior to undertaking any survey identifying the essential steps in overall design from the initial generation of aims and objectives through to the writing up and publication of the final report. Schonlau, Frickerer and Elliott (2002: 41-53) also offered strong guidelines in dealing with the design and implementation of Internet surveys involving the actual questionnaire design, automation techniques together with the implementation and fielding of the survey. Bryman and Bell (2003: 509-510) discussed sampling issues around the use of web surveys and their advantages and disadvantages compared with postal questionnaires Bryman and Bell (2006 512) and concluded that "The electronic-only survey is advisable when resources are limited and the target population suits an electronic survey (Bryman and Bell 2003: 511). Fan and Yan (2010: 137-138) provided suggestions for increasing the response rate of web surveys, whilst indicating that the average response rate is approximately 11% below other survey modes (Fan and Yan 2010: 132). This deficiency rate was also supported by (Manfreda, Bisnjak, Berzelak, Haas and Vehovar 2008: 79).

The Data Capture Process

The layout and content of the survey was a mixture of: multiple-choice 'ordinal' type questions involving a Likert scale format each having a five-point option ranging from 'strongly agree' through to 'strongly disagree'; other 'nominal' type questions requiring specific answers from a drop-down menu; a 'semi-dichotomous' type question, which requested a 'yes' or 'no' response but also had a default of 'no answer'; and four questions requesting comments to specific questions or statements. A decision was made to insert the demographic questions at the beginning to lead the recipients into the full process. The questions were a mixture of both 'open' and 'closed', many having an 'other(s)' option with an accompanying box to provide elaboration. Whilst it is appreciated that the questionnaire was basically a piece of survey based statistical research using a quantitative research strategy, space was provided for textual input as it was considered that the potential level of subject expertise available within the sample, had considerable potential to enrich the overall project and therefore warranted this facility to 'trap' this additional body of knowledge.

The personal data was followed by a section relating to generic questions surrounding data quality in general, relating to the sources and causes of problems and issues and their possible solutions. The remaining part of the main section was focussed within a Remploy context, examining attitudes to the Data Accuracy KPIs, areas of problems and possible methods of improvement, training requirements, overall responsibility for data quality, peoples' perceptions with regard to the quality of data and their attitudes towards Assistive Technology. There were two final questions requesting respondents' opinions, firstly towards the author's own definition of data quality- "Having the right and correct data in the right format, in the right place at the right time, by having one single version of the truth across the enterprise" and secondly a request for any additional comments. A number of the questions

relating to generic data quality were identical to those in Document Four, in order to compare and contrast responses.

Every attempt was made to plan and pilot the questionnaire thoroughly applying the lessons learnt from Document Four. An initial draft was created in Microsoft Excel and circulated to a number of colleagues. The quality of the feedback was positive and the document was refined a number of times, for errors missed during the initial proof reading and to make structural changes to enhance the overall presentation and improve data collection. The refined version was then positioned into Autoform and a couple of pilot respondents then tested the final questionnaire in situ. This final feedback indicated that the survey was accessible and easy to understand and complete.

Autoform was considered to be the most appropriate survey tool for this research in that one had had experience of the application within Document Four where is had worked well especially in the collection of the data and the subsequent integration and analysis within SPSS. One had also received assurances regarding its security as discussed in Section 10. It was appreciated that the tool had certain limitations in that it was somewhat rigid in its format, however it was considered that the other benefits outweighed this and therefore consideration as to the use of an alternative tool was not necessary.

The target audience selected for the survey were the one hundred and eleven recipients of the Data Accuracy KPI Index reports by way of an email. The survey publication timetable comprised:

- Survey set up on Autoform on 20th May 2009
- Initial email sent to all prospective responders on 28th May 2009 with the link to the Autoform survey attached.
- Reminder circulated to Operations Managers on 8th June 2009
- Reminder circulated to Finance Managers on 11th June 2009

The analyses and findings from this survey are described in the following section.

15. INTERNAL QUANTITATIVE RESEARCH- ANALYSIS AND FINDINGS

This section examines the level of responses, analyses the resultant data and then places the findings within the context of the overall research project.

Survey Response

The internal web-based survey was distributed to one hundred and eleven colleagues within Remploy via an email link on 28th May 2009 and by the cut off date of 7th July (the last day any returns were received), forty five respondents had taken part, a response rate of 41%. This was a considerable improvement upon the disappointing return experienced with the Document Four survey. A reasonable response had been anticipated given that it taken place immediately following the series of factory and business meetings described above. A detailed analysis is shown below in Table 9:

Analysis of Responses

Remploy Internal Data Quality Survey May/June 2009

Actions	Date	Cumulative No	Responses %
Publication date	28 May 2009	0	0
	29 May 2009	24	53
	01 June 2009	33	73
	03 June 2009	34	76
	04 June 2009	36	80
Reminder to Operations Managers	08 June 2009	38	84
Reminder to Finance Management	11 June 2009	43	96
	15 June 2009	44	98
	07 July 2009	45	100

Table 9 Analysis of responses

Response Rates

Manfreda, Bisnjak, Berzelak, Haas and Vehovar (2008: 79) and Fan and Yan (2010: 132) both indicated that responses to online surveys tend to be lower than those for more traditional distribution methods. A review of the related literature revealed a very diverse range of average response rates, Cook, Heath and Thompson (2000: 829) reported a 40% success rate; Cobanoglu, Warde and Moreo (2001: 447) 44%; Roster, Rogers and Albaum (2004: 367) 28%; Berger (2007: 12) 'up to 2%'; Poade (2007: 10) '10% or lower'; and Manfreda, Bisnjak, Berzelak, Haas and Vehovar (2008: 90-91) 32%. A white paper published

by (Ipathia (2009: 2) reported that an average response rate of 41% was achieved within199 separate surveys they conducted for clients across industry and local and federal government primarily in the US and Canada. Whilst contributors to a UK blog forum at econsultancy.com had lower expectations stating that; "Best one I've ever seen is 10% but realistically I'd say expect around 0.1%" and "Typically we get anywhere between 0.5% and 10%".

It is appreciated that this survey was distributed to somewhat of a captive audience who had been prepared for the subject matter and in most cases were aware of the importance and implications. Not withstanding, the author felt that the overall response level of 41% was an acceptable size on which to analyse and present findings, draw conclusions and make recommendations, especially when compared with the experiences of the majority of other researchers identified above. It was also obvious that a number of managers had also encouraged members of their teams to participate in the survey, something that had been promoted within the survey invitation email. The timing of responses also appeared to be fairly much in line with that experienced by the majority of similar surveys, in that three quarters of the responses were received within the first week and virtually all had completed within two weeks.

Identification of the variables

In order to ensure that the survey variables are analysed correctly, each question has been identified and its variable type determined to ensure that the appropriate analytical techniques are applied. The guidelines in Bryman and Bell (2003: 240-241) have been used and are detailed below in Figure 10:

Are there more than two categories?

Yes   No ⟶ Variable is dichotomous

Can the categories be rank ordered?

Yes   No ⟶ Variable is nominal

Are the distances between the categories equal?

Yes   No ⟶ Variable is ordinal

Variable is interval/ratio
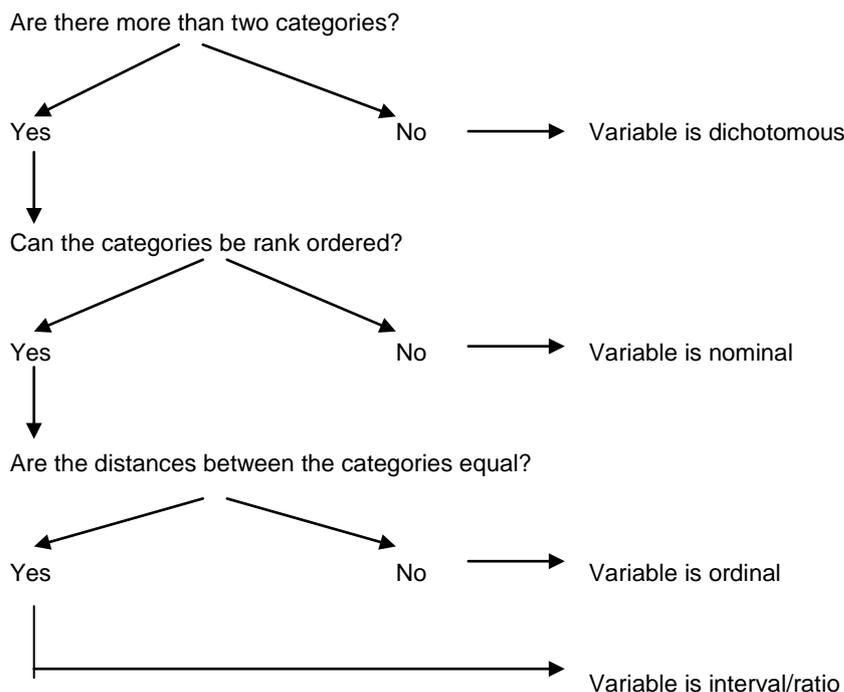
Figure 10 Identifying the types of variables
Bryman and Bell (2003: 240-241)

- Dichotomous: Variables containing data that have only two categories. It should be noted that Autoform allocates to the 'yes'/'no' response questions, a default of 'no answer'. One considers that such questions are semi-dichotomous.
- Nominal: Variables whose categories cannot be rank ordered
- Ordinal: Variables whose categories can be rank ordered but the distances between the categories are not equal
- Interval/Ratio: Variables where the distances between the categories are identical across the range. For the purpose of this survey the two types do not require separation.

Analysis and Findings

The raw data was provided by Autoform via an Excel csv file contained within a secure email from NTU. This data was downloaded into the SPSS analytic tool, subject to the security controls as outlined in Section 10. The data was then analysed within SPSS and extracted via Excel xls files. All sections averaged between 90% and 100% complete, apart from those relating to 'Training' (76% - 78%). This may be explained in part by the fact that some respondents did not see this section as being directly related to them as they were not a departmental head or did not have any responsibility for staff.

Demographic data was requested around job roles and summarised in the Table 10 below.

Demographic Characteristics

Analysis of Invitations/Responses	Invitations Nos	Responses Nos	Response %	Invites Split %	Response Split %
Executives/Business Managers	10	6	60	9	13
Operations	53	19	36	48	42
Commercial	15	7	47	14	16
Finance	26	9	35	23	20
IS	7	4	57	6	9
Total	**111**	**45**	**41**	**100**	**100**

Table 10 Demographic data

This represents a fair cross section of the organisation with all interested parties and functions represented. The response rates vary across the areas with Management, IS and Commercial (which includes supply chain, procurement and logistics) recording the highest rates; however this may be partially explained by the lower number of invitations in these functions and the fact that a greater proportion of the population were more interested or passionate about the subject. Management may also have felt that it had to take the lead and

those members of IS who received an invitation had experienced frustration in the past with data quality problems. It has to be stated that the response level from within Finance was disappointing given that the entire initiative had its foundation within a Finance Conference over three years previously. Part of this might be reflected by the fact that the entire function had been reorganised and restructured towards the end of 2008 with the department centralised within one main base in Leeds with a small sub-base in Coventry. Previously it had been distributed geographically across each business. The result of the reorganisation meant that many of those who had participated in the initial stages were no longer part of the organisation. The largest volume of responses was received from Operations, both at factory and business levels as one would expect given that it was the largest population polled. A response rate of 36% was perhaps lower than anticipated, but there may have been some possible cross-over with the Commercial functions, where a factory manager had delegated the responsibility for responding to a colleague who was subsequently categorised within procurement, rather than site purchasing. However this should not have affected the figures by more than two to three percent.

Analysis of Responses Received

The results from each section were analysed below. The 'ordinal' type questions employed a 'Likert' scale format with five options ranging from 'strongly agree' to 'strongly disagree', with three non-specified points in between. It would have been preferable to title the range 'very high', 'high', 'medium', 'low' and 'very low' but the constraints of Autoform precluded this. For the purpose of the analysis of this document, one chose to aggregate the responses scored as 'strongly agree' and '2' (representing 'very high' and 'high') as indicative of a positive response to the appropriate question. This is also in line with the format used within the Findings and Discussions section of Document Four.

As stated previously this survey endeavoured to gauge the attitudes, thoughts, feelings and opinions of one's colleagues within Remploy, regarding the concepts of data quality and their potential commitment towards its continued improvement. A number of the questions were identical to those used in Document Four, which was conducted within a data quality 'expert' community. This approach is totally consistent, in that this entire enquiry goes to the very heart of 'the quality of data', whether it is in the minds of the academic, the practitioner or the actual person in an operational delivery chain. This analysis evaluated the responses of the two surveys to these identical questions where applicable, to compare and contrast the attitudes and beliefs of both environments.

Generic Data Quality

This section deals with those critical generic concepts which one believes are paramount to improving the quality of data and it is this area that is common to both surveys with a summary of the results shown below. Each question had an alternative 'Others' option and whilst this has provided interesting and rich material in that it enabled respondents to identify any of their personal issues and priorities, the responses showed wide variations in the numbers received and were not considered relevant for this comparative analysis, but will be used in other reviews outside this study.

Table 11 below takes each section and aggregates those responses that are identified as 'very high' or 'high' in percentage terms, excluding 'nil' or missing returns. In line with the philosophy employed in Document Four the author believes that a result of 75% or over may be considered to be 'significant'. A number of results make an immediate impact. Overall the positive responses to the key issues are quite high and whilst there is considerable similarity in both surveys, one may conclude that the 'attitude' towards data quality conveyed in the current Remploy survey is slightly more positive than that recorded by the previous 'Data Quality Professional' survey. It will also be beneficial to review each section in terms of the key concept of 'data', 'processes' and 'people' which has dominated this entire study.

	Remploy Survey 2009 %	IAIDQ Survey 2008 %
How highly will problems in the following areas impact the overall quality of data within your organisation's data systems?		
Master Data entry	88	88
Operational Data processing	84	69
System Housekeeping	79	73
How highly do you evaluate the impact of the following on the quality of the data within your organisation's data systems? (Including non-Baan systems)		
Data Suppliers (persons who provide data)	79	77
Data Processors (persons involved in processing data)	83	76
Data Customers (persons who use the data output)	56	32
How highly will problems in data processes and procedures affect the quality of the data? (including non-Baan systems)		
Level of effect	93	96
Please rank the following as potential causes of data quality problems		

Employees	80	77
Customers	39	44
Suppliers	58	44
External data sources	46	46
Processing errors	80	54
External Systems	31	33
System errors	48	48
Please rank the following as potential causes of data quality problems		
Poor data entry	88	81
Lack of DQ knowledge, training, education	88	69
Poor processes	73	85
Poor management	70	65
Please rank the following in terms of their effectiveness in resolving data quality problems		
Build targets into peoples' objectives	64	
Root-cause analysis of problems	100	
Maintain up-front error prevention	91	88
Identify and clean errors at source	93	84
Identify and clean within the process (i.e. downstream)	59	44
Identify and correct errors in reports	60	24
Take no action	2	4

Table 11 Generic data quality

Summary of the Results:

- 84% Identified that problems with master data and transactional data seriously impacts a company's operations (Data)

- 81% Identified that people who provide and process data have a serious impact upon data quality (People/Processes)

- 93% Identified that process problems seriously impact the quality of data (Processes)

- 80% Identified that employees and processing errors are major potential causes of data quality problems (People/Processes)

- 88% Identified that poor data entry and a lack of knowledge and training are major causes of data quality problems (Data/People)

- 95% Identified that 'root cause analysis', 'up front error prevention' and 'identify and clean errors at source' are vitally important in resolving data quality problems (Data/Processes/People)

From the analysis above it appears that within many areas of the Company, there exists an appreciation of the generic principles of data quality management, providing a strong foundation on which to consolidate the progress made so far.

Remploy Data Quality

The remaining part of the main section was focussed within a Remploy context

	Remploy Survey 2009 %
Attitudes towards the Data Accuracy KPI Index	
How often do you print and review the Data Accuracy KPIs?	
Daily/Weekly	73
(The comparative figure for the 2008 survey was 41%)	
Please rank the following KPIs in terms of their impact in improving the quality of the data	
Credit Notes	59
Despatches Not Yet Invoiced	73
Outstanding Production Orders	70
Outstanding Purchase Orders	86
Outstanding Sales Orders	86
Purchase Orders Under Query	91
Receipts not yet Invoiced	86
Please rank the following KPIs as a source of data quality issues/problems	
Credit Notes	61
Despatches Not Yet Invoiced	56
Outstanding Production Orders	63
Outstanding Purchase Orders	75
Outstanding Sales Orders	68
Purchase Orders Under Query	83
Receipts not yet Invoiced	83

Table 12 Data Accuracy KPI response

Given the fact that not every respondent has a direct responsibility for reviewing the KPI Index on a regular basis, the overall attitude is very positive and may be considered significant. Also the focus upon the seven elements of the KPI Index helped to identify those which are seen as the most important. Not all are relevant to every site, but those which are can be easily identified. The area receiving less attention- Credit Notes, is the one with which the sites have less overall control as other factors exist, which may well explain this variance.

Training requirements

Please rank the system training and developments requirements of your site/department	
Sales	32

Purchasing	57
Production	51
Finance	56

Table 13 Training requirements

Training appears to be less prominent than other sections, although a requirement was identified in certain areas during the site and business meetings noted above in Section 12. When one takes into account, 'medium' scores, alongside 'very high' and 'high', then between 71% and 83% register a distinct interest. Further references to training and development appear later in this document.

Responsibility for data quality

At what level should the responsibility for data quality sit within Remploy	
Everyone	58
Management	42

Table 14 Responsibility for data quality

It is extremely encouraging to see that almost 60% identified that 'everyone' has a responsibility for the quality of data, although it may be a natural response to allocate authority for a major aspect of any business, to 'management' in general. A couple of interesting comments were also made- "Data is a Company-wide asset & belongs to everyone" and "Everyone who uses the system should have an understanding of the system and how things impact each other".

Perceptions and attitudes

How do you feel about the following statements?	
"I am happy with the quality of the data I receive"	26
"I believe I have the ability to influence the quality of the data under my control"	83
"I believe that the quality of the data I provide to others meets their requirements"	81

Table 15 Perceptions and attitudes

This is possibly the most interesting, intriguing and enlightening part of the entire survey and certainly one of the most important. The above responses reveal a great deal about the mindset of the individual respondents. Whilst 82% believe they have the ability to influence the quality of *their* data and provide quality data to *others*, only a quarter believe that the data they *receive* is of equivalent quality, although when one includes those choosing a 'medium'

response, then the figure rises to 69%. There is however a huge disparity within peoples' perceptions and attitudes giving rise to a number of questions. Given that data runs horizontally across departments, functions, sites and businesses from provider to recipient and that the survey represents a reasonable cross-section of this model, one can only deduce that there is either a lack of communication between both parties as to what the 'customer' requires or that the 'supplier' is ignoring such requirements. There is also of course the personal perception that "I am always right and it's the other person's fault" or that no one is prepared to admit that they are not providing a good service. One also has to consider that the population, that did not respond or were outside the scope of the survey, may be responsible in part for this apparent disparity. This entire area is worthy of further investigation outside this study, especially around the area of communication.

Assistive Technology

What % of your team's employees currently use some form of assistive technology?	
0-10%	87
11-25%	9
26-50%	2
51-100%	2
How do you find Assistive Technology?	
Beneficial to everyone	80
Improve the quality of life for disabled users	98
Improve Data Accuracy	72
Have you ever heard of Access to Work and the work they do funding Assistive Technology to disabled users?	
Yes	88
No	12

Table 16 Assistive technology

Accessibility in the form of Assistive Technology (hardware and software techniques developed in order to assist visually or physically disabled persons gain access to information technology within the working environment) appears to have significant visibility within the organisation, but the degree to which it is being applied practically within the areas that matter cannot be determined fully as this stage.

Other Questions

The four remaining questions sought to discover attitudes, opinions and perceptions by means of textual responses rather than by choosing an option amongst a number of predetermined answers

Data quality problems and issues

A number of issues were identified and are summarised below:

		No	%
Data Input and System Errors		8	20
Training and Development		3	8
Liaison with the Share Service Centre		2	5
KPIs	Credit Notes	5	13
	Purchase Orders	4	10
	Purchase Invoices	4	10
	Receipts Not Invoiced	14	34
Total		**40**	**100**

Table 17 Data quality problems and issues

There will be opportunities to follow up on all of these issues

Methods for improving data quality

A number of areas were identified and are summarised below:

	No	%
Review KPIs on a daily/weekly basis	15	48
Identify problems and resolve asap	10	31
Improve processes	3	9
Training and Development	2	6
Others	2	6
Total	**32**	**100**

Table 18 Methods for improving data quality

This result is very encouraging reinforcing the message emanating from the site meetings whilst also supporting data quality best practice

Finally two further questions requesting respondents' opinions were asked:

Author's Definition of Data Quality

To assist with ongoing research, we have attempted to define a working definition of 'Data Quality' which we feel encapsulates our ultimate vision of the subject:

"Having the right and correct data in the right format, in the right place at the right time, by having one single version of the truth across the enterprise"

As already stated in Section 1, of the twenty valid responses, fifteen (75%) were in agreement whilst the remaining five sought to add remarks and observations on accuracy and quality.

There were no negative comments received. As in Document Four the replies appear to be positive and supportive given the rather subjective and emotional nature of the subject.

Additional Comments

A number of interesting comments were received; that there had been great improvements in data accuracy in all areas; the requirement for regular measurement and quantification; the risk of the KPIs driving wrong behaviour; the negative impact of inaccurate data and that there were variations as to the severity of the risks that could effect data quality.

Overall Comment

The overall response to the survey was extremely constructive and encouraging and it identified a significant positive attitude towards data quality in critical areas. Whilst it has to be remembered that less than 50% of the invitees responded and therefore one has to view the results in this context, this level is not inconsistent with similar online surveys as discussed earlier in the section. It is possible that those who did not participate do not view the quality of data in the same way. However, this caveat should not detract from the overall positive results that there appears to be a firm commitment towards Data Quality within Remploy. There is reason to believe that, within a period of three years, data quality now has a profile as high if not higher than that of product quality and heath and safety, in terms of publicity, employee involvement and attention and the impetus towards continual improvement. One's personal definition of 'data quality' also received a positive response, but possibly the most significant result appears to be the disparity between peoples' perception of the quality of the data they receive and their own perceived ability to influence and pass on data of sufficient quality to satisfy their customers' needs.

Summary of the Findings.

Whilst it is appreciated that this survey has been conducted entirely within a work-based setting, it is important that this is then positioned within the overall context of this research project and the broader issues and concerns that emanate from this, for both practice and theory. This sub-section proceeds to summarise the organisational-specific findings into a more 'general' format that will enable them to be applied within a wider environment.

Generic Data Quality

- There is a high appreciation of the influence that People, Processes and Data have on the quality of data
- There is a realisation of the importance of having the data right first time

- The level of positive responses compares very favourably with the previous survey held amongst the data quality community

Remploy Data Quality

- The overall attitude towards measurement, reporting and feedback was very positive
- There was an appreciation of the importance of education and training
- Almost 60% felt that 'everyone' has a responsibility to improve the quality of their own and the organisation's data
- There was a huge disparity between the respondents' perception of the quality of the data they influence (82%) and that which they receive (26%)
- 90% of respondents identified measurement and reporting, problem resolution and process improvement as key elements for improving data quality

These findings are reproduced with Appendix 2.D and will be discussed further within Section 16, as part of the consolidated review of the research outcomes.

This next section brings together the key findings from the entire research, relates them to the key recurring themes from the literature to identify common principles, but then more importantly uncovers those key findings and principle findings which appear to have the potential to inform both professional and managerial practice and the academic community.

16. ANALYSIS OF FINDINGS

Appendix 2 presents in detail, the key findings from this entire research; extracted from the research findings, short term guidelines, issues and ongoing suggestions from the qualitative study; the findings from the Data Accuracy KPI Index performance review; and the summary findings from the quantitative survey. To this has been added further perceived outcomes derived from an appraisal of the entire project over its lifetime, coupled with one's related personal and professional experiences.

Comparison of Key Findings and Key Themes

This section proceeds to take these key research findings and relate them to the concepts of the conceptual framework as depicted in Figure 2 page 18 and the key recurring themes derived from the quality and change management literature review detailed in Table 2 pages 50-52. The initial classification is shown in Appendix 3. The key findings are then compared with the key themes within broad generic common headings in Table 19 below, to identify similarities and variations. Certain key findings have been identified as unique to this research in that there is no related key theme and these are identified in Table 20 below, together with the additional perceived outcomes, to highlight potential additional knowledge on this topic. The concluding part of this section expands further on these key findings and perceived outcomes by examining their implications and potential for informing theory and knowledge as principle findings. Positive practical consequences of this research have already been evidenced by the lasting improvements in the levels of the quality of the data as described by the KPI Index. Section 17 will then establish further that this study has unearthed new insights into the subject whilst adopting a research approach which is certainly not new, but may be considered to be unique within this arena. In this way it is intended to show how new knowledge and unique methodology are able to inform theory and enhance practice and as a consequence improve business performance, in the manner described by Van de Ven and Johnson (2006a) and Van de Ven (2007).

Analysis of the Key Research Findings and Key Recurring Themes related to the Conceptual Framework within Broad Generic Common Headings

Key Research Findings	Key Recurring Themes

A. Cultural/Organisational- Leadership/Management

1. Management and Executive Support

• Executive and senior and middle management sponsorship and involvement	• Executive and Management support and sponsorship

2. Leadership and Culture

- Explain the underlying reasons behind the improvement programme and how it will support the corporate objectives - Sell the concept up and down the organisation - Cultivate an attitude and willingness to embrace new ideas - Better understanding of the underlying principles and requirements	- Establish a clear vision with targets and milestones - Importance of Leadership and Culture - Align the Organisation - Focus upon achievements - Celebrate successes

3. Measurement and Reporting

- Provide regular visible measures and report progress - Measurement of progress and the publication of results - Continually measure, report and provide feedback - Make the measurement and results visible - The overall attitude towards measurement, reporting and feedback was very positive	Measure, monitor with reporting and feedback to support accountability

4. Managing Change

- Identify how the 'measures' will influence the quality of the data - Build in system and structural changes to prevent a return to type - There is potential for real cultural change to take place if improvement initiatives are managed correctly. - Focus on the 'key' elements setting objectives and targets	- Improvement requires change which has to be managed - A belief that change is worthwhile and necessary - Manage the change - Identify risks, benefits and overall objectives - Plan and identify required actions - A continual on-going process - Manage any potential short term and long term conflicts - Tendency for people to revert to type - Elements of quality management principles in all forms

5. Ownership and Responsibility

- Identify ownership and responsibilities - The Businesses 'own' the data NOT IT- a paradigm shift	- Importance of ownership and responsibility - Obtain buy-in, ownership and belief

6. Communications

- Improve communications to share ideas - Communicate across the business on a regular basis	Establish clear channels of communication

7. Positive Approach

Tackle negative cultural issues	- Accept that there will be set backs - Avoid undue pessimism, stay focussed and be positive - Identify potential pitfalls

B. Processes

8. Root Cause Analysis and Improvement

• Ascertain root causes of issues and problems and resolve at source • Ensure that potential problem areas are identified • There is a realisation of the importance of having the data right first time • Potential 'problem' areas identified • Ascertain root causes of issues and problems	• Root cause analysis and error prevention

9. Continual Process Improvement

• Ensure that the appropriate processes and procedures are in place- 'one size does not fill all'	• Best practices within the right environment • Continual process reinforcement • Continual process improvements • Identify and document the process enablers

C. People

10. Education, Training and Development

• There was an appreciation of the importance of education and training • Training, education and development requirements not being met fully	• Importance of education, training and development

11. Objectives, Targets and Reward

• Build data quality targets into peoples' objectives and reward success • Build data quality targets into people's objectives	• Build targets into peoples' objectives with a reward mechanism

12. Involvement

• Involve everyone, provide support • Involve everyone • Hold regular reviews with the 'Team' • Any improvement initiative cannot be undertaken in isolation and that everyone needs to become involved.	• Involve everyone • Teamwork

13. People, Processes and Data

• Identify the personnel dealing with each type of order and agree who does what with responsibilities for each process • Concept of People, Processes and Data .	• Align the processes behind the people • Manage the relationship between the way data interacts between the processes and the people • Concept of People, Processes and Data • Align the processes behind the people

Table 19 Comparison of key findings and key themes

As one would anticipate there is considerable agreement and alignment between the findings and the themes in the majority of the headings, although this research appears to focus more on Measurement and Reporting (3) and Root Cause Analysis and Improvement (8), whilst the quality and change management literature places greater emphasis on Managing Change (4). This again is not surprising given their slightly differing focus.

Additional Key Findings and Outcomes

The analysis of this research also identifies a number of key findings which do not appear to relate directly to any of the key quality management themes. These additional key findings are detailed below in Table 20 alongside those positive outcomes that one has developed during this entire research and over one's personal and professional life

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Key Findings

Cultural/Organisational

Leadership:
- Have an Internal Champion who has the respect of the audience
- A 'Bottom-Up approach with 'Top-Down' support
- What is measured, communicated, discussed and agreed at all levels has a very good chance of becoming embedded"
  - Bottom-up supported by top-down
  - A potential key to sustaining any kind of change?
- The level of progress achieved appears to be commensurate with the level of activity of the internal champions or change leaders, leading to a climate of *controlled sustainability* rather than *self sustainability*

Management
- A need for ongoing support in all areas with an internal 'expert' user community
- Requirement for closer liaison between functions
- Appreciation as to how the KPIs fit within the corporate data and information quality initiative
- 90% of respondents identified measurement and reporting, problem resolution and process improvement as key elements for improving data quality

People
- There was a huge disparity between the respondents' perception of the quality of the data they influence (82%) and that which they receive (26%)
- Ensure everyone is fully aware of the implications of their actions
- Take things slowly to ensure everyone is onboard
- Motivational Factors
  - It is the 'right' thing to be doing, it supports one's principles
  - Belief that it will improve efficiency, help control and manage the factory and department
  - Competition between colleagues
  - Peer and Manager pressure
  - 'League Table' Syndrome
  - Requirement to achieve monthly/quarterly targets
  - A distinct movement away from 'I'm going to be in trouble' to 'My life is better for doing it this way'
- Almost 60% felt that 'everyone' has a responsibility to improve the quality of their own and the organisation's data

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Additional Outcomes

- The Data Accuracy KPIs and the Index is merely a barometer of the effectiveness or otherwise of the related processes- not an end in itself. Any improvement is predicated on the quality of this process and the degrees of adherence of the related persons' behaviour to follow theses processes
- There are two types of processes
  - Operational processes- SOP/POP etc
  - Quality processes- what we need to be done to improve data quality ongoing
- Get the processes right and adhere to them, then the improvement in the KPIs will fall out
- Identify the *processes* (operational and quality) that are required and then change the behaviour (*people*) which needs to take place to ensure the agreed processes are followed continually
- Creating an environment where quality data can be sustained is dependant upon changing the way *people* behave to ensure they follow the most effective and appropriate *process*es and policies to a given situation- process change and people (behaviour) change
- Sustainability requires stability- NOT rigidity
- Identify the changes required to embed a sustainable data quality culture
- From both the qualitative and quantitative studies
  - Emphasise the positive practices (Pros)
  - Review and take action on the issues and problems identified (Cons)
  - Focus on the important cultural environment and ensure that it is place

Table 20 Additional key findings and outcomes

The additional key findings and outcomes described above in Table 20 above have potential to add to the body on knowledge surrounding the sustainability of improvement initiatives per se, however this research is focussed upon a narrower goal, that of 'creating and sustaining data quality within diverse enterprise resource planning and information systems '. Within this overall objective, all of the elements described within Table 19 also come into play, as they all have a potential to impact and influence the ability of all organisations to improve and sustain the quality of their data. This will be discussed in detail below.

Summary of the Key Findings

The conclusions drawn from this study will contend that this research has unearthed new knowledge as to the means by which data quality improvements may be sustained within the environs of diverse enterprise planning and information systems.

Table 19 identifies considerable congruence between the key findings from this research and the key recurring themes emanating from the review of the quality management literature in Sections 6 and 7. A further review of these key recurring themes will testify that a considerable majority of the supporting references identified in Table 2 on pages 50-52 have no direct relationship to ERP or data quality studies. Of those that do focus on enterprise

systems, the majority concentrate on the quality principles of TQM and BPR without any direct reference to data quality and none appear to focus upon its sustainability. From this one feels justified in arguing that the key findings in Table 19 above are basically unique to this study whilst also having generic support from within the quality management arena. This point of uniqueness is extended even further when one considers the findings contained within Table 20 above, none of which are to be found within the quality management literature review. It has to be admitted that none of these key findings are *unique* in themselves when examined in total isolation, however their real exclusivity comes when they are brought together and applied within a specific setting to bring about elements of sustainability. In this way this research brings a new insight into an area largely neglected by the academic community.

Principle Findings

All of these *key findings* in both Table 19 and 20 are important in themselves. They are the series of individual 'actions' that have collectively brought about the changes as witnessed by this research. However from these a number of *principle findings* have emerged which have been identified as those essential elements or concepts that have bound together these individual and potentially disparate actions in order to make these changes happen. The extent to which change becomes embedded and lasting depends upon these principle findings. They are seen as the primary messages from this study.

The 'Cultural/Organisational' heading is a rich vein in terms of achieving a potential knowledge break-through. It focuses upon leadership and management at *all* levels and from this a number of principle findings emerge. The significance of specific project leadership identified as the local *Champion(s)*, together with the extreme importance of continual *measurement, reporting, feedback* with support and encouragement. Intertwined with these threads is the element of *time and maturity.* Sustainability can only be judged in relation to some form of continuum and whilst improvement programmes can go for initial quick wins, *real sustainability* is only achieved when evidenced by its durability and capability to deliver the longer term desired outcomes and values. The 'People' heading also recognises the importance of *maturity* in terms of allowing 'system actors' *time* to come to terms not only with their position within the structure of the organisation and their specific role within an enterprise system, but also to appreciate the importance of data, the purpose of any quality initiatives that may be taking place and the manner in which their own actions can influence the outcomes both positively and negatively. The 'People' category also highlights the most intriguing finding from the quantitative study, that of the differing and inconsistent perceptions as to what appears to constitute quality data as witnessed by the huge disparity between the respondents' *perception of the quality of the data* they influence (82%) and that which they receive (26%). Each of these principle findings is analysed in detail

Role of the Champion

The critical role of the champion in bringing about change and innovation is well established in the literature (Schon 1963; Howell and Higgins 1990; Powell 1993; Shane 1994a; Shane 1994b: Markham 2000; Howell and Boies 2004). Such a Champion or 'heroic local actor' Williams and Pollock (2009:3), can come in many guises. Here one is not referring to the 'Main Sponsor', 'Exec Champion' or 'Strategic Champion' who can provide corporate focus and support however important that can be, but to those 'Tactical or Operational Champions' who have the essential responsibilities and passionate feelings to make the improvements happen. Without such champions any quality initiative is doomed to failure. Every project requires an overall champion to drive the programme forward. Such a person may have been the initial inspiration behind the programme or may have 'emerged' as the ideal candidate. This 'leader' has the specific role to coordinate and provide the impetus with credibility, not necessarily as an acknowledged expert although this would be advantageous, but with interpersonal skills to inspire and bring others into play. Ideally such inspiration should engender a similar impetus in others in more operational type roles to carry the messages within their own communities. It is here where the real sustainability may grow. These latter individual departmental or site 'champions' do not have the title as such and they are not appointed, rather they 'emerge' and assume the role as data quality becomes part of their everyday jobs, built into what they do. This may imply an element of structure possibly within hierarchical environments, but whatever arrangement is in place it must remain flexible and team-based to enable change to occur. Job titles are not important, whether they be Project Manager, Departmental Head, Factory Manager, Supervisor, Purchasing Clerk, Store Keeper etc. The critical element is the acceptance, attitude and commitment to the improvement process. In this way they personify the role of the *data steward*, but not necessarily with that specific title.

This project has followed this pattern, as unofficial departmental and site champions have emerged many exhibiting the motivational factors identified in Table 20 setting data quality objectives within their teams or for themselves. In other areas however local buy-in has not been as encouraging and this is emphasised as one of the key findings in Table 20:
"The level of progress achieved appears to be commensurate with the level of activity of the internal champions or change leaders, leading to a climate of *controlled sustainability* rather than *self sustainability*"

From this discussion one may conclude that part of the process of evolving from *controlled* to *self* sustainability requires a greater proliferation of 'Local Champions' into all environs of the organisation, working in many instances independent of the 'Overall Champion' but sharing the same ideals.

There should also be a note of caution, regarding the transitory nature of the champion. If a champion leaves then this may create a possible vacuum which may lead to the derailing of the entire initiative. Successful champions may be promoted, headhunted or leave for whatever reason, even retirement. This poses a possible dilemma with potential ethical connotations. How should the outgoing champion relinquish their position where a successor has not been appointed or their replacement is not viewed as adequate to carry on the crusade? This situation may also apply to a lesser extent in the case of the exit of a project's executive sponsor, although this may be protected somewhat by the existence of a financially secure project business case.

Measurement, Reporting and Feedback

This study has already identified references within the quality literature as to the importance of measuring, monitoring, reporting with feedback to support accountability Dale (1996); Davenport and Beers (1995); Deloitte (1999); Wood (2004); Zairi (2005); Boult and Eaton (2008); Goyal and Patil (2009) which has also been summarised within Table 2 pages 50-52. Whilst this procedure therefore is not *unique* to this study, its *application* may be considered to have some originality in that it has been used not only as a periodical monitoring and reporting mechanism in the format of the KPI Index, but was also made available in a more detailed format to assist in controlling day to day operations. Considerable efforts were made to try and ensure that this was not viewed as purely a further arms-length 'Head Office Measurement Process' but as a dual-purpose instrument with an emphasis on feedback and assistance, as well as monitoring and reporting, to bring benefits to all parties.

Time and Maturity

The consideration of time and the need for maturity has been discussed in detail in various part of this study; in particular to the requirement for time to allow systems to become embedded (Davenport, Harris and Cantrell 2004). Cerpa and Verna (1998) also applied the maturity principle to information systems and strategic planning, whilst Kochikar (2000) identified certain maturity levels within the major prongs of People, Processes and Technology within a framework for leveraging knowledge. Here the human aspect is vitally important to allow individuals to come to terms not only with their position within the structure of the organisation and their specific role within an enterprise system, but also to appreciate the importance of data, the purpose of any quality initiatives that may be taking place and the manner in which their own actions can influence the outcomes both positively and negatively. Equally important is the requirement to allow time for the necessary skills to broaden and develop beyond the strict confines of the technical aspects of any system Benbaset, Dexter and Mantha (1980); Bartol and Martin (1982), aligning both *people and processes,* 'learning

by doing', the process of trial and error to discover and refine ways of using systems more effectively (Pollock and Williams 2008:85 and Williams and Pollock 2009:4).

This study has also benefited by its longevity. This five year doctoral programme has provided an extended timeframe to undertake a longitudinal study overcoming various pitfalls that can befall ERP studies of much shorter duration, which tend to focus on short term impact, snap shot type research which lack real maturity and as a consequence may have severe limitations (Pollock and Williams 2008:84 and Williams and Pollock 2009:3).

Sustainability as a Process

The concept of sustainability within the context of this study has been discussed and defined within a generic context in terms of maintaining the momentum of the improvements by continuing the trend and thereby looking to improve the current measured result further in the future, an on-going journey of improvement where a continual upward momentum is maintained.

Within the context of this research, sustainability may be viewed as a 'state' which can be measured within specific *time* intervals to determine trends as evidenced from a measurement matrix derived from the Data Accuracy Index. In this guise the maintenance of a continual upward trend (not withstanding intermediate fluctuations) may be taken to imply a state of sustainability. However there may well be a time when the 'improvement curve' may flatten out as incremental improvements become harder to achieve, something which may occur in future to the KPI Index that has seen a 56% overall improvement in the first three and a half years. One then has to weigh the 'marginal cost' of attempting to drive further index improvements, against any 'real organisational 'benefits' that may accrue. It is here where sub-optimisation and the law of diminishing returns may well begin to materialise and one may have to consider an element of trade-off, as has been recognised in other areas of the literature (Helfert, Foley, Ge and Cappiello 2009: 12). Attaining the levels of improvement witnessed so far is considered to be a major achievement and *maintaining* this level of improvement may well be the optimum long term objective of this particular strand of the sustainability process. Previous discussion established that the Data Accuracy Index is not an end in itself, but an indication of the level of public recognition, acceptance and response to the importance of quality data. The longer term focus on sustainability must be to change attitudes, personal cultures and win 'hearts and minds', if the evolution from *controlled* to *self* sustainability is to take place.

Perceptions of Data Quality

The existence of numerous notions as what constitutes 'data quality' and indeed 'data' and 'information' has permeated this entire study, although working definitions were presented earlier within this document. It is therefore not surprising that differing perceptions of 'data quality' exist within the various components of both the qualitative study and quantitative survey. This may best be illustrated by the response to the quantitative research question on perceptions and attitudes on pages 97-98, which was certainly the most interesting, intriguing and enlightening part of the entire survey and arguably the most important, revealing a great deal about the mindsets of the individual respondents. Whilst 82% believed they have the ability to influence the quality of *their* data and provide quality data to *others*, only a quarter believed that the data they *receive* is of equivalent quality, although when one includes those choosing a 'medium' response, then the figure rises to 69%.

This is a huge disparity within peoples' perceptions and attitudes giving rise to a number of questions. Given that data runs horizontally across departments, functions, sites and businesses from provider to recipient and that the survey represents a reasonable cross-section of this model; one could deduce that there is either a lack of communication between both parties as to what the 'customer' requires, or that the 'supplier' is ignoring such requirements. There is also of course the personal perception that "I am always right and it's the other person's fault" or that no one is prepared to admit that they are not providing an adequate service. Although there was a considerable degree of support for one's own definition of data quality, the participants' own view as to what data quality means to them may in many cases take more of a selfish view focussing upon what they *receive,* rather than the requirements as to what they need to *provide* to others. There is also considerable evidence within the literature Laudon (1986); Wand and Strong (1996); Strong Lee and Wang (1997); Giannoccao, Shanks and Drake (1999); Wang, Ziand and Lee (2001); Eckerson (2002); Olson (2003), to suggest that this level of misperception as to data quality within communities, is not unique to this study.

This entire research has been founded upon the robust conceptual framework as described in Section 2 page 18 which brought together the concepts of people, processes and data into a single related model, supplemented by the principles of cultural and organisational change. This has shaped the focus of the entire ongoing research, enabling the outcomes of the literature reviews, qualitative study and the quantitative survey to be brought together within a single structure, allowing the subsequent analysis to draw out those essential key findings and related principle findings which make this entire study unique. These *key findings* and the subsequent *principle findings* discussed above are seen as the main outcomes for knowledge and learning for both practice and theory that have emerged from this research. Within the concluding section below these findings are discussed further within the context of the entire study.

17. CONCLUSIONS AND RECOMMENDATIONS

This study has identified a gap in the literature surrounding the process of improving and sustaining the quality of data within enterprise planning and information systems. This final section builds upon the evidence of this research and in particular the key findings and principle findings in a format that has potential to be applied within practical business and professional settings, whilst providing the academic community with the promise of a contribution to the body of knowledge.

Data as a Key Strategic Resource

This study indicates that the essential principles of sustainable data quality appear to be largely neglected by the majority of organisations. The concept of treating data as an important corporate asset was recognised many years ago Redman (1995: 102); following this Davenport, Harris, De Long and Jacobson (2001b: 1) noted that "Data itself remains one of our most abundant yet under-utilised resources" and in the intervening period there does not appear to have been any considerable change. Latterly Redman (2008: 5) concluded that data and information are essentially being unmanaged, as very few enterprises can claim they meet the necessary criteria to manage their data effectively (Redman 2008: 4). To ensure that organisations are in a position to reap the benefits of data and information as strategic assets, they have to manage them aggressively and professionally as they do their other assets (Redman 2008: 2). In order to achieve this Redman (2008: 2-5) proposed that organisations must focus on the quality of their data, ensuring that it is correct first time, easy to access and understand and protected from misuse. The data must then be put to value-driven use, to assist in making better and more informed strategic decisions. This echoes the earlier works of Davenport (2006a); Davenport and Harris (2007), and Harris (2005a); Harris (2005b); Harris (2007) which centred on the use of 'analytics', moving towards a 'fact-based culture' to generate competitive advantage by harnessing more effectively the power of quality data. This message has been reiterated latterly by Davenport, Harris and Morison (2010: 1) emphasising the total reliance of any analytic project on complete and high quality data.

A PricewaterhouseCoopers survey found that 70% of executives contacted, considered data to be an important asset, yet only 40% felt they used it effectively (Informatica 2008:6). Given the evidence of Redman (2008) above, together with English (2009) and the other sources described in Section 1, these figures may appear be somewhat optimistic, but they do however highlight a gap between realisation and reality and the failure by organisations, for whatever reason, to gain true value from their data assets. A survey conducted by BusinessWeek and Hewlett Packard highlighted the fact that many organisations will readily agree that their data is an important asset, but fail to take any action (Hewlett Packard 2007: 3). One may speculate as to the possible reasons for this apparent absence of activity. There

may be a general lack of attention to data per se at various organisational levels, or that enterprises do not persevere with those initiatives they put in place. Peoples' perceptions of what is and what causes poor data quality appear to have a considerable effect. The significant findings from the data quality survey described in Section 15 regarding peoples' 'feelings' as to the quality of the data they *manage* and that the quality they *receive* illustrates this point profoundly and will be the subject of detailed discussion later in this section.

This research addresses these issues in that it attempts to ascertain how quality data can be created and then embedded within an enterprise. If an effective data quality initiative is put in place it will possess the propensity to raise the profile of data and its value will become more appreciated. As the overall quality is improved, there will be greater confidence in its validity and people will then find better ways of using the information to inform knowledge more effectively, which will in turn enhance decision making. Such positive results will further strengthen the initiative and increase the opportunities for it to become self-sustaining.

The Data Quality Initiative within Remploy has made considerable progress not only in highlighting the importance of data as *the* valuable organisational resource and enterprise-wide asset, but also in generating actions to improve the overall quality in order that it may be used more effectively. Further progress is dependant upon the company maintaining a focus on the quality of its data together with the extent to which the findings, conclusions and recommendation of this study are developed and put into practice.

Enterprise Resource Planning and Competitive Advantage

The literature contains numerous examples of research examining whether ERP systems can provide organisations with sustainable competitive advantage. A number, Kalling (2003); Beard and Sumner (2004); Lengnick-Hall, Legnick-Hall and Abdinnour-Helm (2004); Laframboise and Reyes (2005), employed a resource-based view approach (RBV), an economic tool designed to determine whether an organisation's valuable resources can be a source of competitive advantage focussing mainly on elements of their uniqueness to the organisation (Kalling 2003: 49). Enterprise resource planning per se is not unique, being used, in one form or another, in a great many organisations and for this reason there appears to be a consensus that "an ERP system can yield at most a *temporary* competitive advantage" Beard and Sumner (2004:148); that "ERP does not provide a competitive advantage on its own" Lengnick-Hall, Legnick-Hall and Abdinnour-Helm (2004: 326) and "ERP systems in themselves do not create a competitive advantage" Moe, Fosser, Leister and Newman (2007:37), but are increasingly seen as a pre-requisite to *stay* competitive (Beard and Sumner 2004:148).

The real value-generation elements emanating from ERP systems are seen to be; the availability, quality and standardisation of data…and…improvements in business processes Beard and Sumner (2004:144); improved cultural and learning capabilities aligned with a superior knowledge base….also a platform for increasing social and intellectual capital Lengnick-Hall, Legnick-Hall and Abdinnour-Helm (2004: 326); Lengnick-Hall and Legnick-Hall (2006 190); an information base to outperform competitors Moe, Fosser, Leister and Newman (2007:37); a source of operational excellence information Bendoly, Rosenzweig and Stratman (2008: 320); enhanced processes Fosser, Leister, Moe and Newman (2008: 8-9); and a source of Business Intelligence (Wing 2010: 29). Koh and Simpson (2007: 73) researching within small and medium-sized organisations concluded that enterprise systems could create competitive advantage by showing responsiveness and agility to change; whilst *The American Machinist August (2009: 49)* concluded, "ERP comes down to improving business decisions and increased profitability. With greater knowledge comes a greater chance to succeed". However Seddon (2005: 283) argued that ERP software is an unlikely source of competitive advantage either strategically or operationally.

The debate within the literature described above appears to argue that competitive advantage cannot be derived from solely by implementing an enterprise system. and that achieving any 'real' advantage is predicated on having the capability to add real value and excellence to an organisation's information products and knowledge base. It is worthwhile discussing this further. The above literature is *not* stating that ERP systems cannot provide an organisation with an advantage or that organisational improvement will not accrue, but that if all one's fellow competitors are operating an ERP system then the uniqueness does not exist. The above research is not comprehensive and may not take into consideration the quality of individual implementations. One may contend that whilst there exists a seeming 'level playing field', in reality a firm may gain a competitive advantage over its rivals, if its ERP implementation, optimisation and subsequent system maturity is superior to that of its competitors. The one single element which can add real value to any organisation's information products and knowledge base, whilst enhancing any system implementation and optimisation, is the quality of the data, the 'real differentiator'.

Whilst one cannot state categorically that Remploy has so far derived a *competitive* advantage from its ERP investment, it can certainly be argued that the company is in a far better position to be able to manage and control all of its diverse operations as the result of its improved ERP landscape. Whether further significant advantages can be obtained will depend upon a number of factors, the most important being the ability to maintain high levels of quality data to both further enhance the business and provide quality strategic analytical information, as the ERP life-cycle moves further into the 'maturity' stage.

Enterprise Resource Planning Maturity Conclusions

To reach the point where an organisation is able to manage its data effectively takes time especially where the complexities surrounding ERP systems are concerned. Before an enterprise can learn *how* to manage its data, it has to learn that data *has* to be managed and this may come as the result of learning from previous failures Scott and Vessy (2002: 213); the enterprise resource planning landscape being littered with implementation disappointments and disasters, resulting from a plethora of causes (Chen 2001; Esteves and Pastor 2001; Murray and Coffin 2001; Grossman and Walsh 2004; Xue, Liang, Boulton and Snyder 2004). Holland and Light (2001: 43) described a three-stage ERP maturity model involving; implementation, widening adoption, leading to strategic exploitation, enabling ERP transaction data to provide high-end strategic value to related applications and information and knowledge systems. Markus and Tanis (2000) developed a similar 'ERP experience cycle', which Markus, Axline, Petrie and Tanis (2000: 264) described as a 'set of processes' which can be of varying and indeterminate length, with numerous dependences. A number of the issues they raised has resonance with the findings from this research, in particular cultural questions relating to resistance to change and management buy-in (Markus, Axline, Petrie and Tanis 2000: 263). Whilst this project is not concerned directly with how enterprise systems should be optimised, it recognises that post-implementation reviews are critical Nicholaou (2004: 46) and in particular the importance of the way human resources interact with consistent and optimised processes (Worley, Chatha, Weston, Augirre and Grabot 2005: 635). In order to reach the level of maturity required to enter the real added-value phase, there has to be a move from the reactive 'data inspection and correction', to a far more proactive 'have the data right first time' approach.

Davenport, Harris and Cantrell (2004: 22) highlighted the requirement for systems to become embedded, emphasising the long term evolutionary process of enterprise system maturity, not just in process improvement, but in the very nature of learning what data is available and how to make best use in order to 'informate' or transform the data into information to provide knowledge to support decision making. From..."transactional data, to good business information" (Davenport, Harris and Cantrell 2004: 24). Davenport, Harris and Cantrell (2004: 23) also stressed the importance of overall data quality in bringing about organisational benefits, incorporating data access, availability, quality, consistency, timeliness and accuracy leading to greater familiarity and insight and thereby creating additional demand for more meaningful information. de Souza Dias and de Souza (2004: 153-156) also identified the association between the maturity of enterprise systems and the generation of competitive advantage. A further example of the long term nature of enterprise system maturity, required to gain real advantage, may be seen from the model for turning transaction data into knowledge Davenport, Harris, De Long and Jacobson (2001b) discussed earlier on page 25. The model is partially predicated on developing the skills and experiences of the staff,

together with detailed knowledge of the data. Both these essential ingredients require time to develop and mature before they can be applied to generate any real success.

Whilst the examples above highlight the significance of system maturity and time, one has to conclude that an appreciation of the importance of time and maturity appears to be lacking in most of the related literature which has tended to focus mainly on single site operations Williams and Pollock (2008: 2), of a short term impact, snap shot type studies of fleeting durations, which lack real maturity and as a consequence may have severe limitations. In contrast Pollock and Williams (2008: 83) and Williams and Pollock (2009: 14) suggested that the consequences of enterprise system implementations and their subsequent evolution may have to be considered in temporal framings of years or even decades.

This issue of time and the necessity to allow for the development of systems, people and processes towards their maturity, in order to bring about the real lasting benefits, has direct resonance to the practical elements of this research. Section 8 described the journey towards improving data quality within Remploy over the last five years and makes particular reference to time in relation to the role out of the Data Accuracy KPI reporting, on page 60. It will be beneficial to reiterate again these main sentiments. "*The programme of expanding the circulation and overall corporate exposure may be considered to be somewhat ad hoc in that it did not conform to any initial detailed pre-determined agenda; rather, it developed and evolved over the period, in line with the researcher's own learning process, both as part of this study and as further development of one's practical business experiences. With hindsight the process may have been accelerated a little but the overall aim has been to inculcate rather than inflict the concept. It was also felt that it was important that it be seen as a cross-functional business-wide project rather than a centrally imposed reporting and control structure*". This learning process can be extended within the overall context of the research to encompass not only the researcher's own learning, but also the organisation's learning, commencing with the initial phased Baan implementation during the latter 1990's, onto the individual business optimisations, leading to the commencement of the Data Quality Initiative in 2005 and then finally to the KPI reporting introduced in 2006. This is also reiterated within one of the additional key findings contained in Table 20 'People' above, "Take things slowly to ensure everyone is onboard". It can be argued that part of the overall improvement in data quality can be related directly to the fact that each element has been allowed to take hold, embed and mature.

Davenport (2006a: 107) also emphasised the question of time and maturity in developing companies' analytical capabilities, normally taking several years to come to fruition in resolving technological issues, transactional data refinements, building data warehouses and implementing analytical software. Periods of six or seven years are quoted in order to collect the data, and gain necessary experience to be able to validate the conclusions. In a letter to

the editor of the Harvard Business Review in response to criticism of the slow pace of analytical implementations, Davenport (2006b) argued that analytics is all about slow steady progress…and …over time making small quantitatively derived advantages which lead ultimately to major gains.

Quality Data as a Competitive Advantage

Whilst the majority of organisations have so far failed to maximise the benefits from their planning and information systems, opportunities do exist to create competitive advantage by managing data effectively. Those firms that are able to derive real competitive advantage are doing so by leveraging their data to generate strategic knowledge. This strategic leap is not made by merely implementing business intelligence applications to produce information, but by providing employees with the means of being able to *learn* from the information so as create valuable knowledge with which to make value-driven decisions, by way of a decision making process termed the 'insight-to-action loop' Harris (2005a). To build such an analytical capability requires a change to organisational culture in order that it becomes 'fact-based'. Such 'insight'-driven companies focus on 'facts' in every area of their enterprise Harris (2005b) demanding complete and high quality data (Davenport, Harris and Morison 2010: 1).

As stated, there is also potential for an organisation to gain an advantage over its competitors by making more effective use of its enterprise system to drive its transactional operations. Enhanced processes and developed and engaged people, aligned to improved planning, are better able to reduce lead times, satisfy customer requirements more speedily, maximise revenues, manage working capital and control costs, to optimise operational performance. All of which is also dependent upon being able to manage the data effectively. In this context 'managing data' involves creating and sustaining a data quality culture within which individuals are able to recognise the value of data, improve the quality, embed such improvements and identify opportunities to derive real long term benefits from its use. Without quality data, any enterprise system cannot function effectively, either as the engine to drive the business transactional processes or as source of the data that fuels the management information and business intelligence applications to provide that winning analytical capability. This study attempts to create the climate where such benefits are able to be realised both within Remploy as well as the wider organisational horizons.

Data Governance and Corporate Governance

This study has affirmed consistently the interrelationship between data quality and data governance as enshrined within the conceptual framework in Figure 2 page 18 and in Section 2. In turn data governance has to be linked to corporate governance via corporate leadership. This essential relationship between data and corporate governance also has roots within the

literature (Cheong and Chang 2007; Pfleeger, Trope and Palmer 2007; Tarantino 2008; Weber, Otto and Osterle 2009). The quality of an organisation's data not only has significant commercial connotations, but it also has serious implications for all enterprises, as they respond to the huge number of regulatory requirements, in the form of record keeping, data gathering and recording and information providing. Failure to comply in full to any request can result in serious financial damage to an organisation or even threaten its very existence, even where fraud, deception or other misdemeanours are absent. This not only relates to prominent laws such as Sarbanes-Oxley and Basel II, but to the myriad of government demands for data, whether they be from HM Revenue and Customs, the Office for National Statistics, or any other governmental agency whether UK or Internationally based. All have potential penalties for late delivery or erroneous information. For any unified governance, risk and compliance (GRC) strategy to be successful, there has to be confidence in the quality of the inherent data (Tarentino 2008: 63-64). Whilst this section has focussed upon the importance of data quality in ensuring compliance with regulatory requirements, one is also aware of the necessity for the activities surrounding information systems should themselves to conform to national and international legal obligations (Khadraoui, Leonard, Pham Thi and Helfert 2009).

This dilemma has long been recognised within Remploy. Corporate policies and procedures have been in place for a considerable period particularly within the areas of Finance and HR to ensure both internal and external regulatory compliance. To further strengthen the environment a new IS strategy was developed in 2009. A fundamental part of this was the establishment of a governance body termed the *Design Authority* whose role is to ensure that all elements of IS are consistent with this strategy, which in turn must conform to the overall corporate strategy and governance. The author as a member of this body drafted the initial guiding principles and standards around the management of data together with the data governance policy, described in detail within Section 3.

As an example of the progress made and benefits derived within this field, the following statement appeared as part of the Annual Corporate Business Report submitted to the Executive of Remploy during April 2010:
 "The introduction of a formal Data Governance strategy, allied to improved Data Quality, has strengthened overall Corporate Governance within the Company especially around the elements of Governance, Risk and Compliance (GRC). In addition there appears to be far greater confidence in the quality and value of the information shared and also greater visibility within the businesses, as to their day to day transaction processing"

Summary

The direct operational benefits to Remploy of this study as highlighted by the improved Data Accuracy Index have been referred to in depth, but there is also evidence to suggest that there have also been considerable improvements of a cultural and strategic nature as discussed within this section. Data is not only recognised as a significant resource and a major corporate asset, but actual *resources* in terms of human capital and finance have been expended to support ongoing improvement actions. Further operational and strategic advantages have been derived from enhanced reporting, budgeting and forecasting which may yet be leveraged further to give a real competitive advantage in the future. The myriad of small meaningful ameliorations, both technical and procedural, which have been applied by passionate people during the period since the original Baan implementation, are now gaining greater maturity alongside higher quality data to generate both operational and informational benefits. Finally the recognition of the importance of data in relation to overall governance, risk and compliance has provided enhanced levels of authority and control to identify and mitigate exposure to potential regulatory non-conformities.

Conclusions drawn from the Key Findings and Principle Findings

The analysis of the *key findings* in Tables 19 and 20 pages 102-106 and the subsequent detailed discussion around the *principle findings* which subsequently emerged, are seen as the main outcomes for knowledge and learning for both practice and theory that have emanated from this study. These principle findings have been identified as elements or concepts which assist in binding together those strands of activity that have the capacity to bring about change not only to improve the quality of data but also impart some degree of permanency.

Principle Findings

The *role of the champion* is seen as key to promoting and embedding change and innovation. Within this study local champions have emerged at various levels and from various functions within the organisation embracing the essential cultural and motivational philosophies to make improvements within their spheres of influence. Whilst there has yet to be universal acceptance in all locations there is evidence to suggest that this 'role' is kernel in evolving the programme from 'controlled sustainability' to 'self sustainability'

The concept of m*easurement, reporting and feedback* is a prerequisite for any successful change programme. Within this study this element is not viewed as a mere 'central' monitoring and control mechanism, but has been developed into a reporting process to provide sites and businesses with the information to manage their operations on a day to day basis.

The necessity of *time and maturity* has been discussed in detail earlier within this section as well as other parts of this study. This element of 'organisational patience' is important to allow new 'processes', changes and improvements to become accepted and embedded as well as to enable 'people' to accept change, develop themselves, gain experience and learn new skills.

In discussing the concept of *sustainability,* emphasis has been placed upon maintaining the momentum of improvement particularly within the process of measuring the quality of data. One has to be aware however that there may be occasions where the 'costs' of making further improvements within a particular field may outweigh the benefits that may accrue with the risk of sub-optimisation. Within this study the Data Accuracy Index is not an end in itself but an indicator. In a wider context one is looking to *sustain* the improvement in the levels of awareness and acceptance of the importance of quality data.

The quantitative survey and subsequent related detailed discussions have highlighted the huge disparity in peoples' *perceptions of data quality* between the data they influence (82%) and that which they receive (26%). Whilst evidence from the literature suggests that this is by no means unique to this study it raises considerable concerns in general as to the quality of communication and the way people view their roles and their own performance and the performances of others. It was decided that further analysis as to the underlying reasons for this disparity would best be examined as part of a further research project outside the scope of this study, as it was felt that this additional research theme was somewhat extraneous to the final research question. In addition it is appreciated that the misconceptions in general as to the concepts of data and data quality appear to be prevalent and have parallels within the data quality community as to their own definitions of data quality.

However it is appreciated that the above decision to restrict further detailed work may have placed certain limitations on the analysis of the data carried out for this part of the survey which if undertaken may have enriched the outcomes to determine this the reasons for this seeming 'disparity'. An alternative approach may well have used cross tabulation to provide further analysis around the way participants responded to the question as to how they perceived the quality of data they received. An analysis of this data possibly by function, job role, location, business may have added richness to generate further theories. An attempt was made to garner information of respondents by job role but only a third of the respondents supplied this information. The base data did however contain the respondents' contact details which may also have been used (within ethical principles) to generate a secondary questionnaire to tease out further information. Also it may be beneficial to target the recipients at some later date to see if these perceptions had changed in any way, in terms of a

longitudinal survey. However the restrictions of this study precluded this, but it should not prevent a follow up survey being undertaken as part of further research at some later date.

Final Conclusions and Recommendations

It has been demonstrated that this study has identified a gap in the literature with regard to determining means by which organisations may be able to sustain data quality improvements within diverse enterprise systems. The research is even more unique in that it has been undertaken within an organisation whose objective is to provide employment for disabled people. This research is also distinctive in that it uses an action research approach within this context, with the researcher taking an actual active participatory role in the process rather than acting merely as an observer or recorder of the events. However it must be stated that the researcher did not control the process, but acted as both guide and participant.

Review of the Research Question:

The development of the research questions and their evolution was discussed in detail in Section 1. As part of this process the research questions went through a number of iterations culminating in the final question:

"How can an organisation create an environment where data quality improvements can be sustained?"

The findings, conclusions and recommendations of this study have identified, means by which the quality of data within planning and information systems can be improved, together with the opportunities for such improvements to be *partially* sustained. At the moment any real sustainability exists mainly within a controlled environment requiring periodical interaction by the overall champion, sub-champions and elements of the leadership. Means to achieve *self-*sustainability need to be researched and identified and this will be discussed further.

Benefits and limitations

Rich access

The ability of the researcher to gain full access to such a wide and diverse contact base has added considerably to the overall richness of this research. This is reflected not only in the volume of the sites covered and people interviewed, but also the extent to which virtually everyone appeared eager to participate fully and attempt to make a contribution. Walsham (2006:322) emphasised the extreme importance of having appropriate access to an organisation relevant to the scope and direction of the study.

The application of action research within this study

Discussion within Section 9 identified that action research is not a unique approach within the overall arena of planning and information systems, however the majority of the literature followed the established trend and focussed upon ERP procurement and implementation Akkermans and van Helden (2002); Stefanou and Revanoglou (2006); Walsham (2006); Beyon-Davies, Baker and Williams (2008); Deep, Guttridge, Dani and Burns (2008); Bohorquez and Esteves (2009); system enhancement Klueber and Alt (2000); Adams, Baker, McFadzen, Miller and Smith (2004); and information systems (Baskerville and Wood-Harper 1998; Baskerville 1999; Stirling, Petty and Travis 2002; de Vries 2007). Whilst a number Lee (2004); Lee, Pipino, Strong and Wang (2004) did focus on data quality, they essentially viewed the topic from a generic perspective. This study therefore may be considered to be unique in the manner that it employs an action research approach to generate considerable rich material within the area of sustainable data quality improvement within enterprise systems.

Eden and Huxham (1996:84-85) argued that action research poses potential challenges, around levels of uncertainty, imprecision and instability, a lack of control and understanding of the concepts of consultancy and intervention, which may ultimately prove problematical when used by doctoral students (Eden and Huxham 1996:85). One appreciates these methodological reservations but believes that one's personal and professional experiences both academic and practical, gained over a considerable period of time in a number of organisations, together with an intimate knowledge of the environment being investigated, have acted as a form of 'apprenticeship' for this approach.

The research methods

The qualitative element of the research for this document took the format of a series of discussion-type focus group meetings around a basic flexible agenda, employing an action research approach. To further extend this research and build upon the progress made within the Data Quality Improvement Programme, a web-based survey was then carried out amongst fellow Remploy colleagues.

The research methods employed were dictated largely by their appropriateness to the real-life environment within which the research was conducted, in particular the format of the qualitative focus groups and the ability to make a real contribution to improving business performance. This followed the realisation that a re-launch of the data quality initiative was necessary and that this would be best achieved by working with those colleagues who interfaced directly with the data. As discussed, this process escalated quickly as the benefits were realised by all parties. It is appreciated that an alternative approach could have been taken with a quantitative survey carried out prior to the qualitative study, possibly followed by

a further survey to determine whether perceptions and attitudes had changed. However in hindsight one feels that the chosen process was most appropriate in that it enabled the concept of data quality to be promoted throughout the company by personal contact and that an initial survey may well have garnered little response given the focus at that time on other priorities.

It is appreciated that other research methods were available of both a structured and unstructured nature. In-depth, semi-structured or closed interviews could have been employed but their individual focus would have been far too narrow, lacking totally the essential interactivity between interested participants that proved so beneficial. Similarly, observational research, whether open or closed would not have yielded the same rich material. As a contrast to the use of focus groups, the Delphi technique offered a structured alternative but its closed and rather anonymous nature would not have provided the essential feedback, although its use should not be precluded should further research be undertaken. Whilst the quantitative study was mainly a pre-coded self-administered questionnaire, there was scope and opportunities for participants to express their opinions in number of instances and one believes both elements worked well.

Validation of the research contribution
In validating the contribution that this research has made, one should examine this process through alternative lenses. From a practical work-base perspective within Remploy the importance of the need for quality data is now accepted in greater areas of the organisation and positive feedback has indicated that peoples' perceptions as to the quality of the information they receive and the reliance and trust they place upon it has improved dramatically. This has assisted greatly with the introduction of more sophisticated business intelligence and budgeting tools, leading to the reduction in the regular monthly reporting schedule from ten working days to less than three within four years. The improvements in the levels of data quality as indicated by the Data Quality Accuracy KPI Index described in Section 13, provides further evidence of the practical implications. Also the development of a corporate data governance policy allied to the establishment of a data management presence within the IS Design Authority as described on page 118 can also be attributed solely to this project.

The initial research for this study recognised that a gap existed within the academic literature surrounding the process of improving and sustaining the quality of data within enterprise resource planning and information systems. Subsequent research identified those key findings as described in Tables 19 and 20 (pages 102-106) which are not exclusive in themselves but have the capacity, when aggregated together and allied to the principle findings, to bring about the dramatic changes evidenced by the practical improvements

described above. It is contended that this collective process is unique within the environs of planning and information systems and that this research has therefore unearthed new knowledge with the capacity to make a contribution to the body of literature. It is also argued that the employment of the specific action research approach within this context has also been responsible for developing theory and generating positive practical business outcomes. Therefore it may be seen that the version of action research methodology applied within this research has not only created an environment where lasting improvement process theory can emerge, but actually engenders a cultural atmosphere where such processes can propagate.

This relationship between theory and practice, research and action to attempt to enhance theoretical knowledge whilst providing practical solutions as expounded by Van de Ven and Johnson (2006a) and Van de Ven (2007) has been the overriding ambition of this study. It can therefore be argued that this research has not only made a contribution to *theory* as evidenced by the partial success in answering the final research question, but has also enhanced the reputation of action research as a form of *work-based research,* when applied to situations where the researcher has experience of and credibility within the research arena and all parties have participated actively within the entire process.

Design science

The research for this entire study has been based around the behavioural-science paradigm having its origins in natural science research. Within the arena of information systems research however a complementary approach has gained wider and wider relevance, that of design science. Design science has its roots in engineering and the sciences of the artificial, being essentially a problem-solving paradigm attempting to create innovations or artefacts to improve the analysis, design, implementation and use of information systems (Hevner, March, Park and Ram 2004: 76). Hevner, March, Park and Ram (2004: 98) also argued that behavioural-science and design science are inter-related, the former seeking to find 'what is true' and the latter 'what is effective'; truth and utility respectively, with truth informing design and utility informing theory Hevner, March, Park and Ram (2004: 80); to both improve performance in the development and use of information systems whilst making a contribution to research knowledge (March and Storey 2008: 726). Hevner (2007: 91) contended that design science is essential a pragmatic science with the emphasis on making a contribution that is relevant and measurable, whilst at the same time having the rigor to learn from the existing knowledge base with the potential to contribute to knowledge (Henver 2007: 90).

There has been discussion in the literature as to the relationship between design science and action research in that both attempt to change the world Iivari (2007: 53) and to learn from failures (Iivari and Venable (2009: 11). Jarvinen (2005: 12) argued that both could be

considered to be similar research approaches, both in their characteristics, action and pragmatism and their validation processes (Jarvinen 2005: 13). Iivari (2007: 53) argued from a paradigmatic perspective that they were clearly separate conceptually, and that their paradigmatic assumptions differed dramatically (Iivari and Venable 2009: 12). Whilst Iivari and Venable (2009: 10) accepted the view that action research and design science were in principle compatible, their research orientations were different and that any similarities were superficial and therefore both were decisively different (Iivari and Venable 2009: 12). Approaching the debate from a scientific perspective Ogland (2009: 171) contended that the paradigmatic differences could be overcome and the combination of action research and design science could be a critical success factory particularly within the area of software process improvement research.

Whilst it has been clearly evidenced how design science has influenced information systems research particularly over the last decade, its application within enterprise systems and data quality research appears to be non-existent. From a personal viewpoint design science appears to require far greater direct involvement by the researcher in carrying out the process than one would expect with a comparable action research project. This is certainly the case with this study where the researcher has made every effort not to influence the proceedings. Given the growing acceptance of design science within the information systems academic literature there may be opportunity for future research to examine both data quality and enterprise systems through the lens of a design science approach with or without an alignment with action research.

Potential limitations of a single case

The qualitative and quantitative research for this document was undertaken within a single organisation which may imply certain limitations; however the focus group/action research study and the internal web-based survey did in fact embrace forty eight factories and twelve business streams many of which are quite diverse. This approach takes the process out of a single case environment into a far wider and varied research arena. In addition the survey carried out within Document Four embraced data quality professional from across the world. Therefore it can be argued that the findings, conclusions and recommendations do have a fair degree of relevance to a far wider managerial and professional audience than just a single organisation.

Opportunities for Further Research

Whilst this study has enhanced both practice and theory in integrating both established and largely untested improvement processes and practices into a new environment, it has also identified a number of topics which will benefit from further research outside of this particular

study. It is entirely appropriate that additional lines of investigation worthy of exploration should emerge and this is seen as a further illustration of the benefits of this research. The outcomes may also have relevance externally to this particular sphere. The wider change management community and in particular the process improvement and quality management fraternities may find resonance with a number of the principal findings.

As stated previously the single most important finding to emerge from the quantitative survey was the huge disparity in perception of data quality in that 82% of respondents believe they have the ability to influence the quality of their data and provide quality data to others, whilst only a quarter believe that the data they receive is of equivalent quality. This entire subject is worthy of further investigation outside this study, especially around the theme of communication.

Whilst it is extremely encouraging to witness notions as to how improvement processes are able to generate degrees of sustainability, this must be tempered by the knowledge that only partial progress has been made. Further research is necessary to extend this knowledge to discover those methods by which organisations are able to move from an environment of *controlled* sustainability to one of *self*-sustainability. There is a strong evidence to suggest that the role of 'the champion' in various forms may shed important light within this arena.

Considerable research has taken place within the scientific disciple of neuropsychology, examining the human capacity to accept change, relating to the inner powers of the human mind, in the way that it may support or sabotage efforts to bring about change and achieve buy-in. This may well be a fruitful area for further investigation and the manner in which this branch of science can be applied to data and information quality.

The extreme bias within the literature towards initial-phase related ERP research has already been discussed in detail within the introduction to this study and possibly best illustrated by Pollock and Williams (2008:84) and Williams and Pollock 2009:3) who highlighted the fact that over ninety five per cent of the six hundred plus articles contained in *the ERP Research Group* online bibliography may broadly be described as ERP implementation studies. One believes that there is a strong requirement for far more detailed research allied to the longer term use and development of enterprise systems rather than concentrating upon the procurement, implementation and short-term optimisation arenas. It is hoped that this study has made a much needed contribution towards addressing this academic imbalance and hopefully will encourage and inspire other researchers to undertake similar projects within this area.

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DATA QUALITY RESEARCH PROGRAMME

Research survey to ascertain factors that impact upon sustaining data quality improvements- positive/negative

Analysis of factors

Current Actions/Policies	The way we are doing things currently
Issues/Problems	Issues/problems identified
Action Going Forward	What we are going to do in the short term
Culture-current	Current inherent thinking, attitudes & behaviour
Culture-future	Intended inherent thinking, attitudes & behaviour

Note the Site and Business names have been excluded

No

Appreciation as to how KPIs fit within the Corporate D & IQ initiative	Focus initially on the four key site specific elements (DNYI & orders)	Ascertain root cause of issues/problems	Need to ensure that everyone is fully aware of the implications of their actions	KPIs never understood & never previously cascaded down	Detailed short term action plan- with target dates	Issues with transport & utility bills	Weekly KPI review meetings	Cyber access required	9
Appreciation as to how KPIs fit within the Corporate D & IQ initiative	Focus initially on the four key site specific elements (DNYI & orders)	Training issues identified	Need to ensure that everyone is fully aware of the implications of their actions		Detailed short term action plan- with target dates	Issues with DNYI?	Weekly KPI review meetings	Review credit notes	8
Specific policy re RNIs	Focus on outstanding orders	SSC Issues							3

Contact TOB re any underlying SSC issues	Focus initially on the four key site specific elements (DNYI & orders)	SSC Issues contact keeps changing	Better understanding of the underlying principle & requirements	Confirmation of PO authority levels required		Review RNI principally 'returns'	Weekly KPI review meetings	7
			Need to ensure that everyone is fully aware of the implications of their actions	KPIs never understood & never previously cascaded down	Detailed short term action plan- with target dates	Weekly KPI review meetings	Cyberq access required	5
Low level of business activity		Training issues identified	Need to ensure that everyone is fully aware of the implications of their actions					3
Appreciation as to how KPIs fit within the Corporate D & IQ initiative	No business specific ISBM contact	Dating of order- should be expected receipt/delivery date NOT default date 'today'	Need to ensure that everyone is fully aware of the implications of their actions	Key people left through VR without adequate replacement knowledge & training	Detailed short term action plan- with target dates	Requirement for visit by Tony Taylor	Weekly KPI review meetings	Super User' concept not followed up	9
No business specific ISBM contact	Baan outstanding PO report not complete- missing final	Training issues identified	Need to ensure that everyone is fully aware of the implications of their actions			DNYIs outstanding	Weekly KPI review meetings	6

steps				

Greater publicity of the existence of KPIs	Prioritising of the impact on the business	Need to explain importance of KPIs at both business & site level to help sites take ownership	Need to ensure that everyone is fully aware of the implications of their actions	Toolbox of how to drill down through the reports to understand what has happened & what can go wrong	5

Problem with identifying site specific data from Co 510	Receiving outstanding order lists weekly via email	Printing & reviewing sales orders weekly	Overall performance is good	LRM has back office experience as a former production controller	Pricing of manual POs where actual price not known- 50 @ £1	Requirement for visit by Tony Taylor	7

Good processes in place using Baan	Agreed that KPI data will be used in conjunction with Baan reports	RNIs reviewed weekly by LRM	Baan outstanding PO report not complete- missing final steps	Cyberq access required	5

Process to improve credit notes	Implement automated process to advance dates on 'out to fit' production	Enter anticipated receipt date on POs NOT default date (today)	BFP not known	KPIs reviewed weekly	5

orders						

Problems with carriage charges	Issues with SSC	Issues with raw material price changes-- ownership & responsibility	Problems with incorrect conversion factors	Purchase returns- no process for chasing for supplier credit notes	Weekly KPI review meetings	6
New LRM not fully aware of the KPIs	Focus initially on the four key site specific elements (DNYI & orders)	Enter anticipated receipt date on POs NOT default date (today)	Need to identify the personnel dealing with each type of order & agree who does what with responsibility for each process	Production orders for large volumes are set up as one qty- better if broken into smaller qty orders	Weekly KPI review meetings	6
Agree process for dating production & purchase orders	Issues regarding invoicing for tooling- may take over a year	Process for improving credit notes- print documents	Focussing on KPIs must not sub-optimise day to day operations		Weekly KPI review meetings	5
Contact TOB re any underlying SSC issues	Focus initially on the four key site specific elements (DNYI &	Enter anticipated receipt date on orders NOT default date (today)	Need to ensure that everyone is fully aware of the implications of their actions		Weekly KPI review meetings	5

orders)								
Site not aware previously of KPIs	Should order dates be changed if customers redates orders?	Baan outstanding PO report not complete- missing final steps	Need to ensure that everyone is fully aware of the implications of their actions	Focussing on KPIs must not sub-optimise day to day operations			Weekly KPI review meetings	6
SSC issues	Baan training requirements identified	LRM provides a weekly business KPI summary	LRM has produced business KPI guidelines	Pricing of manual POs where actual price not known- 50 @ £1			Weekly KPI review meetings	6
Some interesting comments (point 8)	Should order dates be changed if customers redates orders?			Purchase returns- no process for chasing for supplier credit notes			Weekly KPI review meetings	4
Everyone involved in the process	Culture of urgency where something needs to happen	Targets set & measured	KPI are beneficial & graphs useful	Assists in identifying & reducing poor practices	Indicative of the quality of the processes	Overall performance is good	Weekly KPI review meetings	8

Review all orders & pass details to relevant person at the start of each month	Call-off orders open for a long time	Set up production orders for smaller quantities covering shorter lead times	Need to ensure that everyone is fully aware of the implications of their actions- financial & transactional	Build DQ targets into people's objectives	Contact TOB re any underlying SSC issues	Requirement for visit by Tony Taylor	To review KPIs to measure progress	8
Ecycle orders not being picked up	Business to use KPIs on a weekly basis	Weekly planning meetings at each site, consolidated at the Centre	Problems with carriage charges on suppliers' invoices	Baan outstanding PO report not complete- missing final steps	Purchase Invoicing problems	SSC issues lack of continuity	Granfos receipts & returns not being contra'd	8
SSC issues lack of continuity	Contact TOB re any underlying SSC issues	Incorporate KPIs within staff's objectives	Importance of the KPIs identified	Focus initially on the four key site specific elements (DNYI & orders)				5
Problems with aggregated sales invoice for Glasgow liaise with SSC	Implement automated process to advance dates on 'out to fit' production orders	Training issues identified	Strictly monitor overdue purchase orders					4
Purchase returns- no process for chasing for supplier credit	Users need more knowledge to tell them which	Loss of skills following Modernisation. Training issues identified	Need to ensure that everyone is fully aware of the implications of their actions-	Automate essential reports & send via email				5

| notes | reports to run to obtain information | | financial & transactional | | |

| KPIs have not been cascaded down to Operations. Staff do not understand the process | Previously not seen as important by LRMs & production controllers- merely lip services | Graphs are good provides visibility | Fundamental to running the business | Cultural issues | Problem with identifying site specific data from Co 510 | 6 |

| Problem with identifying site specific data from Co 510 | Focus initially on the four key site specific elements (DNYI & orders) | Objective to achieve November index target of 21.22 by Christmas | 3 |

| Use super users to communicate and implement 'best practice' | Focus initially on the four key site specific elements (DNYI & orders) | Problems with accounting for consignment stock. Company policy required? | Common process for dealing with carriage charges on suppliers' invoices | Training requirements to be identified by each site | 5 |

Highlight any SSC issues to TOB/Adam	Focus initially on the four key site specific elements (DNYI & orders)	Business/sites to provide feedback on DQ issues	Problems with carriage charges on suppliers' invoices	Maintain ongoing focus on weekly planning meetings	Weekly planning meetings at each site, consolidated at the Centre			6
	Focus initially on the four key site specific elements (DNYI & orders)	Business/sites to provide feedback on DQ issues, problems & successes						2
	Focus initially on the four key site specific elements (DNYI & orders)	Training issues identified	Need to ensure that everyone is fully aware of the implications of their actions	Policy re the re-dating of orders	Detailed short term action plan- with target dates	Issues re DNYI, invoicing & receivables	Review credit notes	7
All sites indicate good practices in place- aiming to be 'the best'	Super User set up but no feedback	Provide all LRMs with access to the GL Transaction Report?	Training requirements identified	No business-specific ISBM	Detailed short term action plan- with target dates	Problems with Aged Inventory Report- not clearing old receipts	Weekly KPI review meetings	8

A lot of bad habits have been carried forward & a lack of understanding in the sites	LRM process focussed: Right first time mentality: Coaching admin support	An error can take 30 seconds but a correction can take hours'	Produce a document covering each KPI highlighting examples of problems/issues with resolutions	Re-age orders as appropriate	New process for reduction of credit notes in Packaging	Review sales orders at daily production meeting	Weekly KPI review meetings	Running new Cyberq RNI report	9
Jobs & roles carried out by people who left under VR need to be identified & picked up	Re-age orders as appropriate	Print KPIs weekly & distribute to the Team	Review Cyberq access						4
Major improvements at all 3 sites	Data accuracy targets built into peoples' objectives	Issue monthly credit note report to all LRMs	RNI returns a big issue	Regular monitoring of KPI index (daily)	Detailed short term action plan- with target dates		Weekly KPI review meetings		7
No follow up on the 'Super User' concept	Multi-despatches on a single invoice with only one detach note number causes problems	Do we check supplier's statements to see if there are old invoices not received?	Access to Accounts Payable enquiry sessions may be useful	Review training requirements	May be useful to cascade GL Transaction Report to all LRMs	Runs aged debtors report weekly	Weekly KPI review meetings	Credit note reasons investigated	9

Total **214**

**DATA QUALITY RESEARCH
PROGRAMME**   **Appendix 1b**

Research survey to ascertain factors that impact upon sustaining data quality improvements- positive/negative

Current Actions/Policies
Issues/Problems
Action Going Forward
Culture-current
Culture-future

Culture-current	No	+/-	Current Actions/Policies	No	+/-	Issues/Problems	No	Action Going Forward	No	Action Going Forward	No	Culture-future	No
KPIs never understood & never previously cascaded down	2	-	Specific policy re RNIs	1	+	Problems with carriage charges	4	Focus initially on the four key site specific elements (DNYI & orders)	11	Strictly monitor overdue purchase orders	1	Appreciation as to how KPIs fit within the Corporate D & IQ initiative	3
Overall performance is good	2	+	Focus on outstanding orders	1	+	Training requirements identified	6	Detailed short term action plan- with target dates	7	Purchase returns- no process for chasing for suplier credit notes	1	Acertain root cause of isues/problems	1

LRM has back office experience as a former production controller	1	+	Low level of business activity	1	?	Issues with DNYI?	2	Weekly KPI review meetings	16	Users need more knowledge to tell them which reports to run to obtain information	1	Need to ensure that everyone is fully aware of the implications of their actions	12
New LRM not fully aware of the KPIs	1	-	Key people left through VR without adequate replacement knowledge & training	1	-	SSC Issues	6	Cyberq access required	5	Automate essential reports & send via email	1	Better understanding of the underlying principle & requirements	1
Site not aware previously of KPIs	1	-	Receiving outstanding order lists weekly via email	1	+	SSC Issues contact keeps changing	4	Contact TOB re any underlying SSC issues	6	Objective to achieve November index target of 21.22 by Christmas	1	Need to explain importance of KPIs at both business & site level to help sites take ownership	1
Some interesting comments (point 8)	1	+	Printing & reviewing sales orders weekly	1	+	No business specific ISBM contact	3	Confirmation of PO authority levels required	1	Use super users to communicate and implement 'best practice'	1	Prioritising of the impact on the business	1

Everyone involved in the process	1	+	Good processes in place using Baan	1	+	Super User' concept not followed up	3	Review RNI principally 'returns'	1	Training requirements to be identified by each site	2	Need to identify the personnel dealing with each type of order & agree who does what with responsibility for each process	1
Culture of urgency where something needs to happen	1	+	RNIs reviewed weekly by LRM	1	+	Baan outstanding PO report not complete- missing final steps	4	Dating of order- should be expected reipt/defivery date NOT default date 'today'	4	Business/sites to provide feedback on DQ issues, problems & successes	2	Focussing on KPIs must not sub-optimise day to day operations	2
Targets set & measured	1	+	Weekly KPI review meetings	6	+	Problem with identifying site specific data from Co 510	3	Requirement for visit by Tony Taylor	3	Maintain ongoing focus on weekly planning meetings	1	Build DQ targets into people's objectives	2
KPI are beneficial & graphs useful	1	+	LRM provides a weekly business KPI summary	1	+	BFP not known	1	DNYIs outstanding	1	Provide all LRMs with access to the GL Transaction Report?	1	Graphs are good provides visibility	1
Assists in identifying & reducing poor practices	1	+	LRM has produced business KPI guidelines	1	+	Issues with raw material price changes-- ownership & responsibility	1	Greater publicity of the existence of KPIs	1			Jobs & roles carried out by people who left under VR need to be identified & picked up	1

Indicative of the quality of the processes	1	+	Review all orders & pass details to relevant person at the start of each month	1	+	Problems with incorrect conversion factors	1	+	Toolbox of how to drill down through the reports to understand what has happened & what can go wrong	1		Access to Accounts Payable enquiry sessions may be useful	1
Importance of the KPIs identified	1	+	Weekly planning meetings at each site, consolidated at the Center	2	+	Purchase returns- no process for chasing for supplier credit notes	2		Pricing of manual POs where actual price not known- 50 @ £1	1		May be useful to cascade GL Transaction Report to all LRMs	1
Loss of skills following Modernisation	1	-	Re-age orders as appropriate	2	+	Issues regarding invoicing for tooling- may take over a year	1		Agreed that KPI data will be used in conjunction with Baan reports	1			
KPIs have not been cascaded down to Operations. Staff do not understand the process	1	-	Using new Cyberq RNI report	1	+	Should order dates be changed if customers redates orders?	3		Process for improving credit notes- print documents	2			

Green		Yellow		Cyan		Pink	
Previously not seen as important by LRMs & production controllers- merely lip services	1 -	Review sales orders at daily production meeting	1 +	Pricing of manual POs where actual price not known- 50 @ £1	1	Implement automated process to advance dates on 'out to fit' production orders	2
Fundamental to running the business	1 +	Runs aged debtors report weekly	1 +	Call-off orders open for a long time	1	Production orders for large volumes are set up as one qty- better if broken into smaller qty orders	2
Cultural issues	1 ?	Credit note reasons investigated	1 +	Ecycle orders not being picked up	1	Set up production orders for smaller quantities covering shorter lead times	2
All sites indicate good pratices in place- aiming tobe 'the best'	1 +			Granfos receipts & returns not being contra'd	1	Problems with aggregated sales invoice for Glasgow liaise with SSC	1
An error can take 30 seconds but a correction can take hours'	1 +			Problems with Aged Inventory Report- not clearing old receipts	1	Produce a document covering each KPI highlighting examples of	1

		problems/issues with resolutions
A lot of bad habits have been carried forward & a lack of understanding in the sites	1 +	
	RNI returns a big issue 1	New process for reduction of credit notes in Packaging 1
LRM process focussed: Right forst time mentality: Coachung admin support	1 +	
	Multi-despatches on a single invoice with only one destach note number causes problems 1	Issue monthly credit note report to all LRMs 1
Major improvements at all 3 sites	1 +	
	Do we check suppliers statements to see if there are old invoices not received? 1	
Data accuracy targets built into peoples' objectives	1 +	
Regular monitoring of KPI index (daily)	1 +	

Total	**27**		**25**		**52**	**71**	**11**	**28**
	+	19	+	24				
	-	7	-	1				**Total** **214**

Analysis of the Key Findings from the Research   Appendix 2

This appendix presents in detail, the key findings from this entire research; extracted from the research findings, short term guidelines, issues and ongoing suggestions from the qualitative study, the findings from the Data Accuracy KPI Index performance review; and the summary findings from the quantitative survey. To this has been added further perceived outcomes derived from an appraisal of the entire project over its lifetime, coupled with one's related personal and professional experiences.

These key research findings are then classified further within Appendix 14 into the main headings of the conceptual framework: Cultural/Organisational- Leadership (L) and Management (M); Processes (Pr) and People (Pe) as indicated below, together with the key recurring themes from the review of the quality literature shown in Table 2 on pages 50-52

A. Research Findings- Qualitative Study

Lessons Learnt

- Take things slowly to ensure everyone is onboard (Pe)
- Identify ownership and responsibilities (M)
- The Businesses 'own' the data NOT IT- a paradigm shift (M)
- Provide regular visible measures and report progress (M)
- Identify how the 'measures' will influence the quality of the data (M)
- Involve everyone, provide support (Pe)
- Explain the underlying reasons behind the improvement programme and how it will support the corporate objectives (L)
- Ensure everyone is fully aware of the implications of their actions (Pe)
- Build data quality targets into peoples' objective and reward success (Pe)
- Ascertain root causes of issues and problems and resolve at source (Pr)

Motivational Factors

- It is the 'right' thing to be doing, it supports one's principles (Pe)
- Belief that it will improve efficiency, help control and manage the factory and department (Pe)
- Competition between colleagues (Pe)
- Peer and Manager pressure (Pe)
- 'League Table' Syndrome (Pe)
- Requirement to achieve monthly/quarterly targets (Pe)
- A distinct movement away from 'I'm going to be in trouble' to 'My life is better for doing it this way' (Pe)

Environmental Factors

- Sell the concept up and down the organisation (L)
- Executive and senior and middle management sponsorship and involvement (L)
- Measurement of progress and the publication of results (M)
- Have an Internal Champion who has the respect of the audience (L)
- Tackle negative cultural issues (M)
- Cultivate an attitude and willingness to embrace new ideas (L)
- Build in system and structural changes to prevent a return to type (M)
- Improve communications to share ideas (M)
- A 'Bottom-Up approach with 'Top-Down' support (L)

General

- The concept of People, Processes and Data (Pr/Pe)
- A mixture of all of the above

B. Guidelines, Issues and Suggestions- Qualitative Study

Short Term Guidelines

- Involve everyone (Pe)
- Continually measure, report and provide feedback (M)
- Hold regular reviews with the 'Team' (Pe)
- Make the measurement and results visible (M)
- Focus on the 'key' elements setting objectives and targets (M)
- Ensure that potential problem areas are identified (M)
- Ensure that the appropriate processes and procedures are in place- 'one size does not fill all' (Pr)
- Communicate across the business on a regular basis (M)

Issues

- Training, education and development requirements not being met fully (Pe)
- A need for ongoing support in all areas with an internal 'expert' user community (M)
- Requirement for closer liaison between functions (M)
- Potential 'problem' areas identified (M)

Ongoing Suggestions (as above)

- Need to ensure everyone is fully aware of the implications of their actions (Pe)
- Better understanding of the underlying principles and requirements (M)

- Ascertain root causes of issues and problems (Pr)
- Appreciation as to how the KPIs fit within the corporate data and information quality initiative (M)
- Identify the personnel dealing with each type of order and agree who does what with responsibilities for each process (Pr)
- Build data quality targets into people's objectives (Pe)

C. Findings Data Accuracy KPI Index Performance

- There is potential for real cultural change to take place if improvement initiatives are managed correctly (M)
- "What is measured, communicated, discussed and agreed at all levels has a very good chance of becoming embedded"
    - Bottom-up supported by top-down
    - A potential key to sustaining any kind of change? (L)
- Any improvement initiative cannot be undertaken in isolation and that everyone needs to become involved. (Pe)
- The level of progress achieved appears to be commensurate with the level of activity of the internal champions or change leaders, leading to a climate of *controlled sustainability* rather than *self sustainability* (L)

D. Summary Findings from the Quantitative Survey

Generic Data Quality

- There is a high appreciation of the influence that People, Processes and Data have on the quality of data
- There is a realisation of the importance of having the data right first time (Pr)
- The level of positive responses compares very favourably with the previous survey held amongst the data quality community

Remploy Data Quality

- The overall attitude towards measurement, reporting and feedback was very positive (M)
- There was an appreciation of the importance of education and training (Pe)
- Almost 60% felt that 'everyone' has a responsibility to improve the quality of their own and the organisation's data (Pe)
- There was a huge disparity between the respondents' perception of the quality of the data they influence (82%) and that which they receive (26%) (Pe)

- 90% of respondents identified measurement and reporting, problem resolution and process improvement as key elements for improving data quality (M/Pr)

E. Additional Outcomes

Additional Outcomes

- The Data Accuracy KPIs and the Index is merely a barometer of the effectiveness or otherwise of the related processes- not an end in itself. Any improvement is predicated on the quality of this process and the degrees of adherence of the related persons' behaviour to follow theses processes
- There are two types of processes
  - o Operational processes- SOP/POP etc
  - o Quality processes- what we need to be done to improve data quality ongoing
- Get the processes right and adhere to them, then the improvement in the KPIs will fall out
- Identify the *processes* (operational and quality) that are required and then change the behaviour (*people*) which needs to take place to ensure the agreed processes are followed continually
- Creating an environment where quality data can be sustained is dependant upon changing the way *people* behave to ensure they follow the most effective and appropriate *process*es and policies to a given situation- process change and people (behaviour) change
- Sustainability requires stability- NOT rigidity
- Identify changes required to embed a sustainable data quality culture
- From both the qualitative and quantitative studies
  - o Emphasise the positive practices (Pros)
  - o Review and take action on the issues and problems identified (Cons)
  - o Focus on the important cultural environment and ensure that it is place

Analysis of Key Findings and Key Recurring Themes related to the Conceptual Framework   Appendix 3

The key findings from the research detailed in Appendix 13 have been classified further into the main headings of the conceptual framework below, alongside the key recurring themes from the review of the quality literature shown in Table 2 on pages 50-52. This is an initial general classification with no intent to compare the findings and themes. This comparison takes place within Table 19 on pages 102-104, where similar related findings and themes have been categorised into thirteen broad generic common headings ((1)-(13)) as indicated below. There are a number of key findings without a comparable key theme and these are indicated as (A) and detailed as Additional Key Findings in Table 20 on pages 105-106.

Cultural/Organisational

Leadership:

Key Findings	Key Recurring Themes

• Explain the underlying reasons behind the improvement programme and how it will support the corporate objectives (2)
 	
• Sell the concept up and down the organisation (2)
 	
• Executive and senior and middle management sponsorship and involvement (1)
 	
• Have an Internal Champion who has the respect of the audience (A)
 	
• Cultivate an attitude and willingness to embrace new ideas (2)
 	
• A 'Bottom-Up approach with 'Top-Down' support (A)
 	
• What is measured, communicated, discussed and agreed at all levels has a very good chance of becoming embedded (A)
    ○ Bottom-up supported by top-down
    ○ A potential key to sustaining any kind of change?
 	
• The level of progress achieved appears to be commensurate with the level of activity of the internal champions or change leaders, leading to a climate of *controlled sustainability* rather than *self sustainability* (A)
	• Executive and Management support and sponsorship (1)
	
	• Establish a clear vision with targets and milestones (2)
	
	• Importance of Leadership and Culture (2)
	
	• Align the Organisation (2)
	
	• Focus upon achievements (2)
	
	• Celebrate successes (2)

Management

Key Findings	Key Recurring Themes
• Identify ownership and responsibilities (5)	• Improvement requires change which has to be managed (4)
• The Businesses 'own' the data NOT IT- a paradigm shift (5)	• A belief that change is worthwhile and necessary (4)
• Provide regular visible measures and report progress (3)	• Manage the change (4)
• Identify how the 'measures' will influence the quality of the data (4)	• Identify risks, benefits and overall objectives (4)
• Measurement of progress and the publication of results (3)	• Plan and identify required actions (4)
• Tackle negative cultural issues (7)	• Measure, monitor with reporting and feedback to support accountability (3)
• Build in system and structural changes to prevent a return to type (4)	• A continual on-going process (4)
• Improve communications to share ideas (6)	• Accept that there will be set backs (7)
• Continually measure, report and provide feedback (3)	• Avoid undue pessimism, stay focussed and be positive (7)
• Make the measurement and results visible (3)	• Identify potential pitfalls (7)
• Focus on the 'key' elements setting objectives and targets (4)	• Manage any potential short term and long term conflicts (4)
• Ensure that potential problem areas are identified (8)	• Align the processes behind the people (13)
• Communicate across the business on a regular basis (6)	• Establish clear channels of communication (6)
• A need for ongoing support in all areas with an internal 'expert' user community (A)	• Manage the relationship between the way data interacts between the processes and the people (13)
• Requirement for closer liaison between functions (A)	
• Potential 'problem' areas identified (8)	
• Better understanding of the underlying principles and requirements (2)	
• Appreciation as to how the KPIs fit within the corporate data and information quality initiative (A)	
• There is potential for real cultural change to take place if improvement initiatives are managed correctly. (4)	
• The overall attitude towards measurement, reporting and feedback was very positive (3)	

• 90% of respondents identified measurement and reporting, problem resolution and process improvement as key elements for improving data quality (A)	

Processes

Key Findings	**Key Recurring Themes**
• Ascertain root causes of issues and problems and resolve at source (8) • Ensure that the appropriate processes and procedures are in place- 'one size does not fill all' (9) • Ascertain root causes of issues and problems (8) • Identify the personnel dealing with each type of order and agree who does what with responsibilities for each process (13) • There is a realisation of the importance of having the data right first time (8) • 90% of respondents identified measurement and reporting, problem resolution and process improvement as key elements for improving data quality (A) • Concept of People, Processes and Data (13)	• Best practices within the right environment (9) • Continual process reinforcement (9) • Elements of quality management principles in all forms (4) • Continual process improvements (9) • Root cause analysis and error prevention (8) • Concept of People, Processes and Data (13) • Align the processes behind the people (13) • Identify and document the process enablers (9)

People

Key Findings	**Key Recurring Themes**
• Take things slowly to ensure everyone is onboard (A) • Involve everyone, provide support (12) • Ensure everyone is fully aware of the implications of their actions (A) • Build data quality targets into peoples' objective and reward success (11)	• Obtain buy-in, ownership and belief (5) • Involve everyone (12) • Build targets into peoples' objectives with a reward mechanism (11) • Importance of education, training and development (10) • Importance of ownership and responsibility (5)

• Motivational Factors (A)
  o It is the 'right' thing to be doing, it supports one's principles
  o Belief that it will improve efficiency, help control and manage the factory and department
  o Competition between colleagues
  o Peer and Manager pressure
  o 'League Table' Syndrome
  o Requirement to achieve monthly/quarterly targets
  o A distinct movement away from 'I'm going to be in trouble' to 'My life is better for doing it this way'
• Involve everyone (12)
• Hold regular reviews with the 'Team' (12)
• Concept of People, Processes and Data (13)
• Training, education and development requirements not being met fully (10)
• Need to ensure everyone is fully aware of the implications of their actions (A)
• Build data quality targets into people's objectives (11)
• Any improvement initiative cannot be undertaken in isolation and that everyone needs to become involved (12)
• There was an appreciation of the importance of education and training (10)
• Almost 60% felt that 'everyone' has a responsibility to improve the quality of their own and the organisation's data (A)
• There was a huge disparity between the respondents' perception of the quality of the data they influence (82%) and that which they receive (26%) (A)
	• Teamwork (12)
	• Tendency for people to revert to type (4)
	• Concept of People, Processes and Data (13)
	• Align the processes behind the people (13)