A framework for managing timetable data quality within the NMMU

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Summary

This dissertation investigates the influencing factors on timetable quality, not only from a data quality perspective, but also from an information quality perspective which takes into account the quality of the business processes involved in creating the timetable. The Nelson Mandela Metropolitan University was used as a case study for assessing the quality of the timetable process, the quality of the source data, and the quality of the final timetable produced. A framework for managing the data quality during the timetabling process is proposed. The framework is based on reviews done on data quality management best practices and data quality aspects.

Chapter 1 introduces the current Nelson Mandela Metropolitan University timetable, and motivates why data quality management is essential to its success. The scope and research objectives are presented for this dissertation.

Chapter 2 covers a literature study on business process and data quality management best practices. The common thread through all the management methodologies investigated, was top management involvement and commitment to continuously improving the quality of data.

Chapter 3 discusses various characteristics of data quality. Quality is determined to be whether the end result meets the quality requirements for which it was intended. Hence each system could have quality aspects that are unique to it.

Chapter 4 explains various research designs and which were followed for this dissertation. The combination of literature studies, a questionnaire and a case study were used.

Chapter 5 is a case study of the data quality and timetabling processes used at the Nelson Mandela Metropolitan University and is based on the research design described in chapter 4. The current business processes followed in setting up the current timetable are presented, as well as the proposed timetabling process that should produce a better quality timetable for the Nelson Mandela Metropolitan

University. The data quality aspects most pertinent to the Nelson Mandela Metropolitan University are determined, being timeliness, accountability, integrity and consistency, as well as the most probable causes for bad timetable quality, like uniform technology, processes, ownership and using a common terminology.

Chapter 6 presents a framework for managing timetable data quality at the Nelson Mandela Metropolitan University using an Information Product Map approach that will ensure a better quality timetable. Future research is also proposed.

It is evident from this dissertation that data quality of source data as well as the quality of the business process involved is essential for producing a timetable that satisfies the requirements for which it was intended. The management framework proposed for the Nelson Mandela Metropolitan University timetabling process can potentially be used at other institutions as well.

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List of Abbreviations

APQC	Academic Planning and Quality Committee
CTO	Central Timetable Office
ERP	Enterprise Resource Planning
HR	Human Resources
IP	Information Product
IPMAP	Information Product Map
ISO	International Organisation for Standardisation
ITS	Integrated Tertiary Software
NMMU	Nelson Mandela Metropolitan University
PET	Port Elizabeth Technikon
QA	Quality Assurance
TQM	Total Quality Management
UPE	University of Port Elizabeth

Chapter 1: Introduction

1.1 Background

In any organization, decisions are based on the information provided and the systems which provide that information. Inaccurate or inconsistent data hinders a company's ability to understand its business problems, causing lost profits, operational delays and customer dissatisfaction (DM Review, 2007). The performance of a company is dependent on the value of the organization's data (Henderson, 2005).

At the merged Nelson Mandela Metropolitan University (NMMU), bad data quality and inconsistent data systems have been inherited from the previous institutions that have lead to ineffective, inaccurate provision of information. This influences decisions as well as customer satisfaction. The best way to introduce this is by example.

The timetable was previously captured on different systems by the pre-merged institutions. When the institutions merged, all campuses were expected to use the standard Enterprise Resource Planning (ERP) timetabling system. This however, did not cater for the added complexities introduced by the new academic structure as well as the difficulties encountered when merging all the additional venue information upon which the timetable is based. This resulted in part of the timetable being captured on the ERP system, and another part being captured on spreadsheets. To rescue the situation, a third party system (Abacus O!Timetable) was purchased which could automatically work out and optimize a timetable for the university based on venue, academic structure and program information provided to it. The O!Timetable would then be able to feed this optimized timetable back into the standard ERP system. Unfortunately, although the business process made logical sense, the information upon which it was based and the number of programs it was required to cater for did not seem to agree. How then, can data quality issues be managed in relation to the business process?

Data quality has many aspects, from the accuracy of the data itself, through to the quality of the end result. Dimensions of data quality that have been identified are usually related to the environment within which an organization operates. Some of these dimensions are Accuracy, Timeliness, Completeness (National Division Diabetes Program, 2003), Consistency, Validity and Ease of Use (Stephens, R.T. 2007). In other organizations quality dimensions have been Accountability, Ownership, Security and Confidentiality (National Division Diabetes Program, 2003).

Consistency can be defined as the extent to which data is collected using the same procedures and definitions across collectors and times (Stephens, R.T. 2007). Considering that a process effectively manages data, it should follow that all processes use the same data quality procedures or controls and a commonly derived set of definitions.

1.2 Timetables

Timetabling systems are most often used for storage and retrieval of timetables, instead of optimized decision systems (Deris, Omatu, Ohta, & Samat, 1997). A considerable amount of research has gone into algorithmic or modeling approaches to working out timetables in a suitable amount of time. Many papers have been published dealing with various aspects of timetables and other scheduling systems like timetabling optimization and program methods for schools (Wright, 1996), universities (Deris et al., 1997; Sabin & Winter, 1986) and flight centers (Bazargan-Lari, 2004) among others. The biggest problems that these researchers encountered had to do with centralized versus decentralized timetabling, the flexibility of the timetable produced and the constraints required to make an automated timetable usable to the end users.

1.2.1 Centralized versus Decentralized Timetabling

Small scheduling systems like the flight centre preferred decentralized timetables as this allowed changes by the instructors and students themselves, especially as their flight times were dependant on unpredictable circumstances like the weather. Here

they made use of a weekly web-based timetabling scheduler that could cope with constant change (Bazargan-Lari, 2004). On the other hand, more complex timetabling systems like universities and schools mostly made use of centralized timetabling methods, as this allowed for scheduling in blocks which could be timetabled in parallel (Boland, Hughes, Merlot, & Stuckey, 2008). The more complex situations encountered at schools and universities proved more easily automated when the timetable was centrally controlled (Boland et al., 2008; Deris et al., 1997; Wright, 1996). When timetables are centrally controlled, the data would most often also come from a central data source.

1.2.2 Timetabling Optimization Methods

A number of algorithms and methodologies have been implemented to solve the complexities of timetabling programmatically. Among these are Integer Linear programming methods (Boland et al., 2008), the Heuristic Search method (Wright, 1996) and Constraint Based Reasoning methods (Deris et al., 1997) among others like Neural Networking, Graph Coloring, Genetic Algorithms and Knowledge based methods (Deris et al., 1997). All these approaches attempt to find the most optimized solution for a timetable, taking into account a number of constraints like time slots, available rooms, number of subjects and the number of lecturers or teachers. The advantage of these systems is the reduced amount of time it takes to produce a timetable automatically versus creating a timetable manually. The draw-back of most of them is that they tend to be inflexible once a timetable has been scheduled.

1.2.3 Constraints Encountered

All timetable scheduling systems have had to take a number of constraints into consideration. And to make matters more difficult, these governing parameters of the timetable constantly change (Bazargan-Lari, 2004). The basic data required by a timetable included classes (also referred to as subjects or lessons), rooms (also referred to as venues or locations), time-slots (sessions or periods), number of students (or learners) and the lecturers (also referred to as teachers, staff or personnel). These five basic components have to be fitted together to come up with a suitable and

usable timetable. Unfortunately, many more constraints are placed over and above these, depending on the individual situation. For example, most universities have their classes differentiated into class types like tutorials, practicals or lectures. This is something that is not included in the linear optimization methods (Boland et al., 2008). Other constraints encountered included situations where a class may only have one lesson per day, or the teachers or lecturers may only be available for certain sessions or time-slots (Boland et al., 2008). In the case of schools, each student must have a lesson scheduled for every session of the day (Wright, 1996). Alternatively, universities have to take into account a student's unscheduled time. This leads to the "block" approach where classes could be related to one another in "blocks" to ensure that they were scheduled together (Boland et al., 2008).

Other common constraints were teacher and lecturer preferences (Deris et al., 1997; Wright, 1996), which were represented as important objectives to be met, instead of hard constraints. So apart from the combinatorial problems of the timetable, there are also dynamic problems where variables and constraints can change along with the changing requirements of the organization (Deris et al., 1997).

A further complication with university timetables versus school timetables is that most universities allow students to choose their own subjects as long as the pre-requisites are met, which further complicates the construction of a timetable. And to even further complicate the matter, there is usually a limited time in which a timetable must be generated taking into account the limitations on available rooms, sessions, lecturers and usually unlimited combinations of subject choices (Deris et al., 1997).

Many timetabling systems ignore constraints like the size of the rooms versus the size of the classes, the various class types, or the flexibility required by lecturers. Once a timetable has been generated, it remains inflexible and makes rescheduling a nightmare. This is one of the disadvantages of having a centralized timetable. Most computerized timetabling systems disregard the more qualitative issues that make a timetable acceptable to the users thereof (Wright, 1996).

The constraints touched upon here highlight various aspects of data quality that would make the difference between a good and usable timetable, and a bad one. In order for users to use the timetable system optimally instead of just as a place for storing, retrieving and printing information, it needs to have the qualities of flexibility, adaptability, portability and timeliness. All timetabling systems, no matter what optimization methods they make use of, are dependent on the correct initial setup of the underlying systems and data structures (Deris et al., 1997). They assume that the data provided to the timetabling system is accurate, and that the end result of the timetabling process is usable. Determining what quality aspects are most critical to making timetabling successful will be part of this dissertation.

At the NMMU there is already a timetabling system in place, so a new timetabling system will not be proposed. The assumption made in this dissertation is that any algorithm or system output is dependent on the quality of the input, the quality of the transformation services in place, and the quality of the end result produced. In other words, the quality of the entire process. Therefore this dissertation will focus on evaluating and identifying these quality aspects in relation to the current timetabling process followed at the NMMU, and to propose a framework with which to use the current process optimally, while producing results for the timetable that are of a high quality as determined by the users of the timetable.

1.3 Problem Statement

From the introduction so far, it is apparent that a lot of effort has been put into timetable optimization on a low level, but very little has been considered regarding quality dimensions or how the business process could affect the quality of the final timetable produced. This study is therefore aimed at identifying the key causes in the provision of bad information quality - “The quality of the output resulting from the information systems” (Stylianou & Kumar, 2000) at the NMMU, using the timetable as a case study, and proposing a framework within which to manage quality information provision in relation to business processes (Stylianou & Kumar, 2000), as the one is dependent on the other (Karacsony & Terry, 2007). This is just one aspect of Data Resource Management (DRM) (Henderson, 2005).

The timetable is based on data owned by other departments, as well as on more than one technology, making it difficult to control the quality of information produced by the timetable business process.

The purpose of this dissertation is to find out what the impact of inconsistent data and programs, and therefore inconsistent information provision are on the NMMU's business processes based on various quality aspects determined from the environment of the business process being studied. How does data quality and the technology used affect the required result of a certain business process – in this case, the timetabling process? From this a way can be proposed to manage the quality of information for a particular business process.

1.4 Statement of Objectives

Four research questions, as can be seen in Figure 1.1, were proposed, starting with the current NMMU timetabling business process, through identifying relevant data quality issues and the status of them in the current timetable, to proposing a way in which the timetable can be improved upon by managing the process in conjunction with the quality dimensions for future use.

Research Question	Objectives	Methodology	Deliverable
1. What is the current Business Process at the NMMU for creating a Timetable?	To determine the Business Process in place and the impact on other data systems up-stream and down-stream of it.	Interviews.	Specification or final outcome of what is to be achieved with the timetable.
2. What are the NMMU's requirements in relation to data quality in the timetable?	To determine what quality standards are necessary for the timetable.	Questionnaire;	Quality Metrics for the NMMU's timetable.
3. What are the data and technology characteristics of the timetable?	To determine the data quality of the current timetable, and what the causes may be.	Interviews; Questionnaire.	State of the current data in relation to the metrics determined in 2.
4. What future preventative measures can be put in place?	Propose a re-usable framework for managing information quality for the timetable.	Literature study.	Framework for managing timetable information quality.

Figure 1.1: Research Questions, Objectives and Deliverables

1.4.1 Research Questions

What is the current Business Process at the NMMU for creating a Timetable?

This research question aims to determine the current Business Process in place at the NMMU, and the potential impact on other data systems up-stream and down-stream of it. The objective of this question is also to identify the data sources and fields necessary for the NMMU's timetabling process. This objective will be met through interviews with stakeholders from the central timetabling office and an end-user of the finished timetable. The deliverable to this step will be a business process diagram depicting the current process in place, including the data required and where that data is to be sourced from.

What are the NMMU's requirements in relation to data quality in the timetable?

The second step is to determine what quality standards are necessary for the timetable specifically relevant to the NMMU. This will be based on the literature study on general data quality characteristics and business process best practices done in Chapters 2 and 3. From the data quality aspects identified here, a questionnaire with questions pertaining to each data quality

aspect will be answered and rated, from where the most essential data quality aspects can be identified for the NMMU timetable. Only the top few quality aspects will be focused on for the rest of this dissertation. Along with this, the questionnaire will contain questions aimed at identifying causes, or perceived causes for bad timetable data quality. The deliverables for this second step are the most relevant data qualities pertinent to the timetable at the NMMU.

What are the data and technology characteristics of the timetable?

Step three is to determine the data quality of the current timetable, and what the causes may be. This will be done through the second part of the questionnaire.

What future preventative measures can be put in place?

The last research question aims to highlight the gaps between the current NMMU processes and the best practices identified during the literature study. The outcome of this would be a framework for managing timetable information quality at the NMMU.

1.5 Methodology

In order to reach the objectives above, a combination of a questionnaire, interviews and literature studies were used. If the cause of an ineffective timetable is bad data quality, then the first step was to determine what the main data quality aspects were that were sought within the NMMU's timetable. Two literature studies were done, one on business process best practices relating to quality control, and the second literature study dealt with various aspects of data quality. Once the data quality dimensions pertinent to the timetable business processes had been determined, the quality dimensions most important to the users of the timetable at the NMMU were focused on. This section made use of a questionnaire as discussed in more detail in Chapter 4. Once the most important quality dimensions responsible for an effective timetable had been determined, the business process used in order to produce the NMMU lecture timetable was determined, along with the relating data sources represented at each stage, and then the quality dimensions were related directly to this business process.

To conclude this research, based on the findings, a framework for managing data quality within the timetabling business process is proposed.

1.6 Conclusion and Layout

The literature on timetabling is far from complete when related to business processes and quality control. Certain aspects of data quality, like flexibility, consistency, accuracy and timeliness, have an effect on the usefulness of any timetable produced. These aspects are determined right at the beginning of the timetabling process with the capturing of the timetable data, and the data sources used to produce the timetable, as well as the flow of data throughout the business process. Very little literature is available regarding data quality control within the timetabling process in any organization. Using the NMMU timetabling process as the basis for this research, this dissertation aims to investigate this area.

The layout of the dissertation is as follows:

Chapter 1 motivates the reason for this study, and gives the objectives and methodology used.

Chapter 2 contains the literature study on business processes and data quality management methodologies already used by other organizations. The conclusion of this chapter is used to formulate a management framework specific to the NMMU timetabling process in the final chapter.

Chapter 3 is a literature study on the characteristics of data quality. The data quality aspects most likely to influence the timetable process are identified and are used later in the case study and conclusion, relating them to the NMMU timetabling process.

Chapter 4 discusses the research design followed by this dissertation, relating it to questions specific to the NMMU.

Chapter 5 is a case study on the NMMU timetable following the research design discussed in chapter 4. The business processes and data quality of the current NMMU timetable is investigated, analyzed, and related to the literature studies done in chapters 2 and 3.

Chapter 6 concludes the dissertation by stating the problem to be solved and the objective achieved. A management framework specific to the NMMU timetabling process in proposed, making use of the information gathered from the two literature studies and the case study done at the NMMU. Future research is also proposed.

Chapter 2: Business Process and Quality Control Best Practices

2.1 Introduction

The quality of the timetable depends on the type and quality of the process that is followed in order to produce the timetable to its specified requirements. Currently at the NMMU, the Central Timetabling Office (CTO) is dependent on data that is owned by other departments. Therefore the quality of the data provided to the CTO will impact on the quality of the timetable delivered as an end result. It is therefore important that the process most suited to the NMMU would be one that takes the quality processes both upstream and downstream of the CTO into account as well, instead of simply focusing on one business area.

This chapter explores various best practices and quality control methodologies relating to business processes, as the process followed in order to produce the NMMU timetable will be related to these in a later chapter. The most appropriate process will be identified for the NMMU by discussing a range of process methods used by other organizations.

2.2 Quality Control Methodologies

2.2.1 Total Quality Management & Quality Assurance

Total Quality Management (TQM) focuses on the requirements of the customer and the proactive pursuit of continuous improvement. It is an integral part of an organization making it each employee's responsibility. In essence TQM focuses on continuous improvement, customer satisfaction, team work and management responsibility, which is integrated into a quality organizational culture. Total quality management is a less systematic, more dynamic approach to Quality Assurance (QA). Quality assurance uses documented processes and systems to prevent defects and promote quality conformance and control (Waddell & Stewart, 2008). Both processes use key performance indicators or critical success factors to measure the performance of the quality control process.

In a study done on a Malaysian organization, TQM was implemented and the "soft" critical success factors analyzed. Only one out of five TQM projects had achieved any significant improvement for their organizations in the USA and Europe. Therefore critical success factors not normally taken into account were measured to see their impact on the success of TQM instead of only using financial or production indicators. It was found that the main "soft" elements affecting TQM were culture, trust and teamwork, although other factors like employment continuity, training, top management leadership quality and customer involvement also had an impact on the success of TQM to a lesser extent (Lau & Idris, 2001).

A practical implementation of quality control involves four basic steps, namely: define, plan, perform and correct. Although most quality control processes have been applied in manufacturing environments, they can also be applied to service organizations like educational institutions. Firstly the service required must be defined, secondly, providing the required service must be planned, thirdly, the service must be correctly performed to the required quality standard, and finally any quality shortcomings must be corrected (Caplen, 1969). Various performance measures are used to determine whether the required quality standard has been reached. Unfortunately, these measures are most often controlled by the finance division of a company, making the measures one sided. Therefore it is necessary for performance measures to be part of a business process whereby they can continually be re-evaluated to suit the business objectives and strategies (Kuwaiti, 2004).

2.2.2 Business Process Management

A process can be defined as a series of interactive activities that transform input to output that has a specific purpose (Kuwaiti, 2004). Quality control therefore has to be part of the business objectives and process (Trillium Software, 2006) to ensure the quality of the output. Business process management is meant to start and end with the customers, users or stakeholders. From here, business process management crosses functional boundaries in the organization, linking together tasks or activities in a logical sequence or process. By crossing functional boundaries within the

organization it makes the company more competitive, flexible, innovative, efficient, customer focused and profitable (Davis & Heineke, 2005; Hammer & Champy, 1997). This was originally suggested by Hammer & Champy (1997) through reengineering the business, but later a more conservative approach of business process management was taken by organizations.

Business process management has a closed lifecycle which involves the design, configuration, process enhancement and diagnosis of issues within the process. This describes the various phases of operational business processes. In the first phase, the design phase, the processes are actually designed and aligned to the business's strategy. The configuration phase is where the designs are implemented. The enhancement phase is where the operational business processes are performed using the system configured, and the last phase is the diagnosis phase where the operational processes are analyzed to identify problems and to find possible improvements (Weske, van der Aalst, & Verbreek, 2004). Business process management aligns all levels of an organization to the business strategy and objectives on a continuing basis by putting controls, ownership and responsibilities in place.

In order to analyze business process management, it is important to remember that it is dependent on the output of other business processes, and other business processes are in turn dependent on the output of the process under evaluation. The first step in analyzing a business process is to define the process boundaries. It is important to define where the process begins and ends, the inputs and outputs of the process, and the other processes in the organization that either affect it or are affected by it in the organization. The second step is to link the process to the overall strategy of the business, or in other words, the organization must understand how the process contributes to its competitive advantage. The third step in analyzing business processes is to map the process in the order in which the steps are performed, how long each step takes, and what resources are required. The various steps are often grouped by functional area to illustrate the cross-functionality of the process. The process can then be benchmarked to compare it with similar processes, and performance measures allow management to identify potential problems and make improvements to the implementation of the process (Davis & Heineke, 2005).

Today it is acknowledged that the ownership of any business process by senior management is usually essential to its success (Kuwaiti, 2004; Trillium Software, 2006). This includes the development of a performance measurement system by senior management which guarantees their endorsement and participation which is critical if business process is to succeed. Ownership of the business process is also essential as business process measures change with the changing needs and objectives of the organization, which means that the measures used for a particular process will need to be adaptive to change. In a study done on the management of a performance measurement system, it was noted that many of the functions that needed to be performed had a technical aspect to them that would require information technology. Trillium Software (2006) and Kuwaiti (2004) also pointed out that each unit was responsible for its own operational information, so suggested an overall performance system manager was necessary, with operational unit information owners reporting to him/her, although difficulties and politics between business units were expected (Kuwaiti, 2004). The proposed process for ensuring data quality in projects also raised similar issues and suggested a similar solution of roles and ownership responsibilities. Executive leaders needed to take ownership of the process on a whole, the line-of-business managers would take ownership of their operational areas, data stewards and information professionals would ensure that the correct measures were in place (Trillium Software, 2006).

Therefore any function in an organization can be managed using business process management processes and relevant and correctly identified measures. But the success thereof is still determined by soft issues like ownership and senior management support.

2.2.3 Six Sigma

Six Sigma is a quality management control framework that improves quality by analyzing data with statistics to find the root cause of quality problems, and to implement controls to rectify them. It is the modern day derivative of TQM. Business process management may embed Six Sigma initiatives into their process designs in

order to reduce the cumulative costs across the value chain (Smith & Fingar, 2002). Six Sigma is mainly used in manufacturing environments as they tend to have more transactional and production data upon which to base the statistics compared to service organizations. But the basic methodology would work in either. Six Sigma bases its quality measurements on the idea that the range between the mean of a quality measurement and the nearest specification limit is at least six times the standard deviation of the process. Six Sigma aims to reduce this process variation to approach zero defects with only 3.4 defects per million opportunities. Its main goal is continuous improvement (Markarian, 2004; Smith & Fingar, 2002). It includes detailed analysis, fact-based decisions and a control plan for the ongoing quality control of a process. This makes it a very "top-down" approach to quality management and requires top management support (Markarian, 2004).

The objectives of Six Sigma are to define what process variables are critical to the product quality and to define gaps between what you want to achieve, and the current performance. For this to work, full-time, dedicated staff are trained and appointed to the quality project. These owners are called Black belts or Master black belts. Reporting to them you have staff who keep their existing job and only work part time on six sigma projects. They are called Green belts. In addition to these staff members you get the process owners like operators and engineers who are directly responsible for the process (Markarian, 2004).

The Six Sigma lifecycle may follow various processes. The most common one used follows the DMAIC pattern – define, measure, analyze, improve and control. Customer input is essential to initially identifying the factors that are critical to quality (Markarian, 2004; Smith & Fingar, 2002). The define stage approaches the customer to identify what their "Critical to Quality" issues are, as well as the core business process involved. This is essentially the customer's requirements for the products or services. Once that has been done, the performance of the core business process involved is measured. This step involves data collection and metrics which are then compared to the requirements that the customer defined in the first step. Once the gap in the quality requirements has been identified, the business process and the data collected is analyzed to identify the causes of defects and to identify any opportunities

for improvement. The opportunities for improvement are then prioritized according to the requirements of the target process and improvements are implemented either by using technology or process training. Finally the improvements made need to be controlled through ongoing monitoring, documentation and structural changes (Smith & Fingar, 2002).

Ultimately Six Sigma is a practical form of Total Quality Management that can be incorporated into business process management is order to improve the overall cost and performance of that business process.

2.2.4 ISO 9000

The International Organization for Standardization (ISO) prepares international standards so as to improve the quality and interaction of organization's products and processes. These standards can be used internally or externally by Certification bodies, to assess the organization's ability to meet customer, regulatory and internal requirements (ISO 9001, 2000). The ISO 9000 guidelines were created as a set of standards for Quality Assurance in organizations specifically aimed at improving quality and quality management. The ISO 9000 series is based on eight quality management principles, namely: customer focus, leadership, people involvement, process management, a systems approach to management, continuous improvement, factual decision making and mutually beneficial supplier relationships (Waddell & Stewart, 2008).

ISO 9000 combines other quality management methodologies into a standard management framework as a comprehensive whole for the organization, making the business strategies and objectives the starting point for quality management and improvement thereby aligning the quality requirements with the organizational strategy and customer expectations. It stipulates the general management requirements for a quality management system like documentation, management responsibility, resource management, product planning and measurement, analysis and improvement. It does not represent a set of rules to be followed, but rather

guidelines as each organization has its own unique set of requirements or strategies (ISO 9001, 2000).

ISO 9001 adopts a process approach for improving quality management which is focused on customer satisfaction. Therefore the customer plays a large role in defining the requirements of the process. The process is based on four aspects, meeting requirements, seeing the process as adding value to the organization, measuring performance and continuous improvement. It does this using the "Plan-Do-Check-Act" (PDCA) methodology. In the planning phase, objectives and necessary processes are identified according to customer requirements and organizational policies. Doing involves implementing the process. Checking includes measuring and monitoring the process against policies, objectives, and requirements. The "Act" phase means taking corrective action to improve the process performance where shortcomings have been identified (ISO 9001, 2000; ISO 9004, 2000).

Quality management according to the ISO 9001 best practice covers documentation of all requirements, processes, and quality policies. ISO 2001 and ISO 2004 quality management documentation includes quality policies and objectives, a quality manual, documented procedures, work instructions, forms, quality plans, specifications, external documents and records (ISO/TR 10013, 2001). ISO 9001 also stresses top management involvement in communicating the quality policy and objectives to the whole organization, as well as making the resources available that are required for the level of quality expected, and reviewing the process analysis reports. Human resources are also included in quality management as a whole as they are responsible for the personnel resources, training and infrastructure. The step of Product Realization involves the actual process planning, customer involvement, purchase, design and development of the quality process. Finally continual improvement is maintained through measurements and analysis. It is recommended that customer satisfaction always be used as a measurement to determine the success of the quality process, to see whether the organization has met customer requirements. The quality process is then continually improved upon by implementing corrective and preventative actions (ISO 9001, 2000; ISO 9004, 2000).

Performance improvement measures highlight the fact that process ownership and the alignment of the quality policy with the business strategy and objectives is crucial to the successful operating of a quality management process. As the knowledge of an organization stems from the information it accumulates, it is important that management treat data as a fundamental resource as it is crucial for making factual decisions. ISO 9004 also points out that associated support processes and their desired outputs should use control measures and be considered when setting up the process for product realization, as their output becomes the input to other processes (ISO 9004, 2000).

As part of the management review of the quality management process, aspects like the reliability and repeatability of the process should be considered, as well as the consistency of the inputs and outputs with planned objectives. If changes are necessary, a proper change control process should be implemented to ensure that the changes benefit the organization and satisfy the needs and expectations of interested parties. It should also check that the measuring and monitoring systems in place are maintained accurately to accepted standards in order to provide confidence in the data provided (ISO 9004, 2000).

Possible forms of measuring and monitoring that can be used for the quality management system are the "voice of the customer", where data from the customer is collected via questionnaires, surveys and various reports. Internal audits measure the capability of the process, the use of information technology, the quality cost of data, and the adequacy and accuracy of the performance measurement used. Another way to measure performance is to use a self-assessment which addresses questions like "is it simple to understand and use, how does it impact the organization resources, and does it enhance the performance of the organization's quality management system?" (ISO 9001, 2000). From this a Performance Maturity Level can be assigned to the quality management process in place in the organization. These levels start at 1 as having no formal approach to quality management, to 5 which indicates the best quality management system in its class (ISO 9004, 2000).

Although ISO 9001/9004 is extremely comprehensive in its quality management best practices, it focuses at a high organizational level and does not delve deeply into basic quality control systems with specific purposes to a specific organization. As it is aimed generically at all kinds of organizations, this is an unwritten expectation that each organization will use their own method of implementing quality controls.

2.2.5 Quality Control Cycle

Effective quality management frameworks in use by various companies may not include all the aspects of the processes previously covered, but have been simplified for more specific and practical purposes. This section describes a method used where quality was controlled and improved in practice. This is especially useful for data clean-ups or during and after the migration of legacy systems and focuses on the implementation rather than the management perspective of quality control. Once again as in the methods mentioned previously, the methodology used focused on repeatability and well defined objectives (Karacsony & Terry, 2007).

The Data Quality Cycle is a standardized data quality strategy comprising of four main stages: discovery, definition, remediation and prevention. As the name implies, it aims for continuous improvement by being repeatable (Karacsony & Terry, 2007).

The Discovery stage involves identifying the data quality problems and prioritizing them according to the business drivers and objectives. The cost estimate involved and possible solutions are also investigated in this stage for the purposes of cost justification. The deliverables and clear objectives are stipulated, and the measurements for effectiveness are identified in the first stage. At this point a decision is made whether to continue with the data quality initiative in question (Karacsony & Terry, 2007).

The second stage is the Definition stage. Here measurement criteria are defined which could include measurements of conformance, validity, syntax, completeness, precision, accessibility, timeliness, or any other measure that is relevant to the business process impacting on the data. From here a team is chosen, including

business experts and must be approved by senior management. Before continuing with the plan, the data problem needs to be analyzed, or defects measured and the true cost established so that the actual versus estimated costs can be established. This allows you to tie it back to the initial objectives and make any resource adjustments at this point rather than later. If the costs are not worth the effort, then the project can be stopped (Karacsony & Terry, 2007).

In Remediation, the third stage, the decision has been made to implement the data quality initiative. The extent of the data quality problem must now be established by identifying the upstream and downstream business processes that would influence or be influenced by the affected data. In other words, the complete information cycle. From this the sources of data that need to be fixed can be identified as well as all the subdivisions that would need to be incorporated into the future prevention plan. It is important that all subdivisions have the same consistent understanding of the data that is being shared and collected. Using this technique allows you to identify the organizational root cause of data problems, whether it is inconsistencies between divisions, or a system error (Karacsony & Terry, 2007).

Lastly, the Prevention stage is implemented. Once again, this ties in with the other methodologies already discussed in that top management support and clearly defined roles and responsibilities are crucial to the data quality cycle's success. It is recommended that a data governance program and data policies are implemented. The expected benefit from the reduced data quality issues must be assessed to see if the prevention plan is worthwhile. Either way, the data quality cycle must be repeated to ensure good quality management (Karacsony & Terry, 2007).

This is a practical approach to implementing the best practices mentioned in TQM and ISO 9001, but also takes relating business processes into account.

2.2.6 IPMAP

The Information Product Map (IPMAP) is an approach to efficient data quality management in environments that have large, widely distributed data sources with

many stakeholders as is found in e-businesses. This mapping technique represents the whole manufacturing process of an information product, including quality dimensions and measures at any stage of the process to assist with implementing total data quality management. With multiple and distributed data sources over which decision-makers have no control, it makes it difficult to guarantee data quality. Therefore data quality management should include either informing or providing the decision-maker with the ability to gauge the quality of the data which they use, based on the decision-makers specific requirements (Shankaranarayanan & Cai, 2005; Shankaranarayan, Zaid, & Wang, 2003).

The concept of an IPMAP assumes that the production of an intellectual product follows basically the same steps as manufacturing uses for creating a physical product. Raw materials (data), storage (data sources), assembly (data capturing), processing (assimilating information), inspection (reporting and validations), rework (data modifications/updating) and packaging (formatting) are all part of a similar process. Typical intellectual products are management reports, invoices, or any other systems that make use of the underlying data. Typical TQM methods that are applied to manufacturing environments can therefore also be applied to intellectual product processes. An IPMAP provides a comprehensive visual representation of the intellectual property process, as well as the flow of data elements through different business units and across organisational boundaries. IPMAP identifies ownership, processing, location, system used, composition of product, and organisational/information system boundaries by using a set of constructs. Each construct has its own shape, similar to data-flow diagram shapes, to represent tangibles and intangibles like data sources, processing, data storage, inspection, information system boundaries, business and organisational boundaries, and data sinks or the consumer's finished product. Each construct has metadata associated with it indicating what, where, how and by whom. This includes a unique identifier, composition of data unit, ownership, processing requirements and constraints, the technology used and the physical location of where the process is performed. It could also be enhanced to include the time dimension of when a process takes place (Shankaranarayanan & Cai, 2005; Shankaranarayan et al., 2003).

By visualising the movement of data products across system and organisational boundaries, it assists with understanding and evaluating the quality implications of such movements. Quality dimensions such as timeliness, accuracy and completeness can be represented as components of metadata. Each step in the process has a quality value associated with it which is passed into the next step in the sequence. Using this method, decision-makers can assign their own weighting to the quality values based on their own experience to evaluate the data quality at any stage in the intellectual product process. The information manager can also identify the sources of information, the organisational unit responsible for it, the individual responsible, and the organisational and system boundaries spanned by the process which would impact on the data quality. Using the IPMAP method, continuous improvement, critical paths and time based management can also be staged and implemented (Shankaranarayan et al., 2003). Shankaranarayanan & Cai (2005) give a more detailed analysis of how IPMAP can be used to evaluate completeness and have automated it to resemble workflow modeling tools.

By using the IPMAP methodology, quality management information can be more easily assimilated and evaluated, tracing it directly back to the source and business area responsible for that data. It is also a more practical approach to total quality management.

2.3 Conclusion

Managing data quality has been a concern for organizations for many years. From the methodologies discussed in this chapter, the most often mentioned factors are top management's involvement, ownership, continuous improvement and relevant performance measures. TQM, ISO 9001 and Six Sigma take a high level perspective of quality management across the organization as a whole, while the Quality Control Cycle and IPMAP provide practical ways to implement quality management within a certain process. The section on business process management describes the best ways to manage business processes, of which quality control is a process that must be managed.

Roles, responsibilities and ownership of quality processes were highlighted as crucial factors that could either make or break the success of a quality management system implementation. Various methodologies suggested similar top-down reporting paths to be set in place before starting the quality process, starting with senior management, through line management, to process and data owners. Training and documentation were essential to effective communication and efficient data quality management and improvement.

One aspect that not many of the methodologies discussed in depth was the impact of the quality of the business processes upstream and downstream on the process being analyzed. Data quality issues in one source would affect the quality of the output of any process making use of the same data source. Therefore the quality management system would need to encompass a broader perspective of all related business units.

Another thing to consider is that these are all business management processes which only make use of information technology as an enabler and not as the driving factor or main initiative for implementing quality management. This is supported by Trillium Software (2006) and Vosburg & Kumar (2001) who state that processes, people and business expertise are the major components to improving data quality.

Currently the NMMU CTO office uses data owned by various business units, making ownership and responsibilities an imperative aspect to be considered when choosing a quality management methodology. It may be more useful to combine the most appropriate and relevant features of several methodologies to suit the situation at the NMMU, rather than try to force a best-fit approach.

Today it is considered a necessity that all organizations should adopt a quality management system that will provide accountability, consistency, understanding and continual improvement, and that this should be integrated into management systems (Waddell & Stewart, 2008). Due to the fact that organizations are using information more and more for knowledge management which is seen as an intangible asset, it makes sense that the quality of the underlying data is controlled. To be able to do this,

the quality aspects of this data must be identified, as will be discussed in the next chapter.

Chapter 3: General Characteristics of Quality Data

3.1 Introduction

The definition of quality is usually tightly related to the expectations from the specific system in use. Quality means different things to different people, but one of the oldest definitions of quality is whether "the quality in question is satisfactory for the purpose for which it was intended" (Caplen, 1969, p. 3), or in other words conformance to specification (Shankaranarayanan & Cai, 2005; Waddell & Stewart, 2008). This definition of quality is supported by definitions that include excellence, value and meeting or exceeding customer expectations (Waddell & Stewart, 2008). Unfortunately, quality is dependent on the quality of the data and information captured and manipulated within the system – garbage-in, garbage-out (GIGO). Much time and effort has been spent on data clean-up operations as companies realize that data is an important asset and bad data quality can result in wrong decisions and lost revenue (Smith & Adelman, 2006; Vosburg & Kumar, 2001; Waddell & Stewart, 2008). As pointed out by Smith & Adelman (2006), it is easier and cheaper to capture the data correctly rather than trying to fix it later in the cycle. Since data quality is therefore specific to the required outcome expected within an organization, the various data quality aspects will also tend to be organization specific.

Numerous and varying data quality issues have been identified in different organizations depending on the type of business outcome expected. Some are standard quality issues like completeness, accuracy, continuity and timeliness (Shankaranarayan et al., 2003; Smith & Adelman, 2006), while other data quality issues are not as simple to identify, but have an impact on the final product nonetheless, for example, the integration of technologies used to deliver the data (Healy, 2005), flexibility, ownership and whether data is still being used for the original purpose it was created for. Most research pertaining to data quality has focused on the quality of the captured data. For example, incomplete telephone numbers, null fields and duplicate records (Smith & Adelman, 2006; Trillium Software, 2006). This is however only a small part of data quality which can only be properly evaluated as the output resulting from the information systems

(Stylianou & Kumar, 2000). Data is the essential component of knowledge upon which an organization runs, when data is combined, say from different geographical locations or functional areas, it yields information, which when transformed and used creates knowledge (Waddell & Stewart, 2008, p. 33).

Various aspects of data quality will be discussed in the following section as they have been related to their specific areas of study.

3.2 General Data Quality Aspects Identified

Organizations have different criteria for determining the quality of data. For example, the National Diabetes Program needs specific aspects of data quality (National Division Diabetes Program, 2003) which overlap with the same aspects of data quality needed for industrial companies using ERP systems (Healy, 2005; IBM, 2007; Vosburg & Kumar, 2001). The most common data quality aspects are accuracy, completeness, timeliness (Shankaranarayan et al., 2003; Stephens, 2007) and consistency (Stephens, 2007; Wang, Reddy, & Kon, 1995). These are only a few of the quality aspects used in other studies. Depending on the quality of the requirements, other data quality aspects have been identified like validity (National Division Diabetes Program, 2003; Smith & Adelman, 2006; Stephens, 2007), integrity (Healy, 2005), ease-of-use (Stephens, 2007), accountability (Trillium Software, 2006), accessibility (National Division Diabetes Program, 2003) and flexibility as was identified as a crucial aspect of timetable optimization downfall (Deris et al., 1997).

More extrinsic qualities were also identified based on the quality of the information systems that also affect the ultimate quality of data and data systems. These are aspects like uniform technology (Healy, 2005; Vosburg & Kumar, 2001), ownership and data interpretation (Vosburg & Kumar, 2001), procedures (Stephens, 2007) and the use of common terminology (Vosburg & Kumar, 2001). Any one of these aspects can result in dirty data, generally because the initial requirements for the data were not known, or the data was not treated as a strategic business resource to start off with, resulting in data quality problems (Vosburg & Kumar, 2001).

3.2.1 Data Integrity

As Vosburg & Kumar (2001) state, the integrity of data used for opperations and making decisions about the business affect the efficiency of opperations and the quality of decisions made. If the quality of data cannot be trusted, it results in dissatisfied customers, loss of shareholder confidence, unneccesary material and labour costs as well as the cost of time spent trying to correct the data. Data integrity can only be maintained if dirty data is controlled and users are made aware of the importance of quality data. Data integrity can therefore be seen as the amount of confidence that the data shareholders have in the data they use to make decisions and run their daily operations on. This is especially evident during data integration projects like mergers, upgrades and the integration of external products with a central ERP system.

Healy (2005) identified some of the probable causes of poor data integrity. These included people responsible for the data in the first place having moved on, an application was outsourced and the vendor supporting it no longer exists, emergency data updates were done under severe time pressure and no documentation was done regarding the changes, the documentation about a system and the changes made were lost, and proper data entry standards, policies and accountability were not in place. He suggested that continuous data profiling, either manual or automated, was necessary in order to ensure data integrity over time.

3.2.2 Timeliness

Timeliness is about whether data is available when needed and on time to improve business management (Stephens, 2007). The timeliness of data could be dependant on many other factors like whether the data is drawn from a data repository which is only updated once in a while, or whether it is real-time transactional data. It could also depend on the data transformation programs or reporting mechanisms in place that could potentially delay the timely provision of the data.

Wang et al. (1995) specify timeliness as the recorded value not being out of date. The importance of the timeliness of data can be seen especially in on-line businesses that use customer purchasing behaviour as an example (Fang & Rachamadugu, 2009). As new data is constantly being poulated into a data source, it is important to know the timeframes within which data loose its usefulness as out-of-date information usually carries a cost, even though this may be difficult to quantify (Fang & Rachamadugu, 2009).

Timeliness of data also depends on whether the data has been entered correctly in the first place. It takes time to investigate, understand and correct errors encountered because of dirty data. The time taken for this is considerably more than the time it takes to prevent the problems in the first place. Therefore the time to delivery of data can be solved to a large extent through training and documented procedures (Vosburg & Kumar, 2001).

3.2.3 Accuracy

The accuracy of data is the extent to which it is free from significant error. The accuracy of data is usually the most easily quantified as it can be represented by a percentage of source elements that are considered correct (Smith & Adelman, 2006). The accuracy of data within systems needing to be integrated has a significant impact on the success of such integration projects, for example, the implementation of SAP and other ERP systems (IBM, 2007; Vosburg & Kumar, 2001).

Accurate data means that the data in question has no duplicate records, no records with duplicate primary keys, no null or blank critical fields, and that the data definitions are adhered to, like standardised metric units of measurement and standardised formats of data entry for fields like telephone numbers and addresses (Trillium Software, 2006). Data definitions add meaning to the data stored in a database, it also ties the data of a specific field to a business entity. If the business entity cannot be identified from the data captured, then the accuracy is compromised, as often happens as organisations evolve over time. Inaccurate data is most often inherited from legacy systems where data quality was not considered as important as

what it is today, as well as from non-standardised data entry procedures (Vosburg & Kumar, 2001).

3.2.4 Validity

The extent to which data represents actual performance is considered to be the validity of the data (Stephens, 2007). Usually only the data owners on the business side can tell you whether data is valid or not. The way in which validity can be measured is as a percentage of the occurrences within a source element that contains a value that falls within an accepted range of a target element as specified by the data owners (Smith & Adelman, 2006).

Validity was specified as having to be precise and accurate and what it was purported to be by the Diabetes Program (National Division Diabetes Program, 2003). You can only know whether data is valid if you share the same understanding of the data across functional business areas. For example, a lack of understanding is common between data generators (business users) and report writers (usually technical staff). In the case of Vosburg & Kumar's (2001) ERP integration case study, they showed how the business user knew that a promised shipping date on an order together with a production block was not valid, but the consultant writing the report did not. Therefore, for the case of this study validity can be stated as whether the data is a true reflection of what it is has been defined as by the data owners.

3.2.5 Consistency

Consistency is one of the core data quality aspects identified in most data quality papers (Smith & Adelman, 2006; Stephens, 2007; Wang et al., 1995). Consistency has been defined as the extent to which data is collected using the same procedures and definitions by all involved over time (Stephens, 2007), where the representation of a data value is the same in all cases (Wang et al., 1995). Consistency can also be seen as data elements containing the same value representation across various data sources and systems. It can be measured as the percentage of occurrences of a source element that have the values in agreement with those contained in the same element of another

data source (Smith & Adelman, 2006). One of the lessons learned during the ERP integration project, was that all users across the organisation should understand data in a manner that was consistent throughout the organisation. The best way in which to achieve consistency was to integrate the business functions on a single system so that all data was available from one source. In this way reporting would also be more consistent, and an integrated ERP system had the additional functionality of validations upon data entry screens (Vosburg & Kumar, 2001).

Quality of data is improved through consistency. Therefore consistency can be determined by whether the same procedures, definitions and systems are used across the board to capture, manage and disseminate data.

3.2.6 Flexibility

As data qualities are aspects of a system that determine whether it is fit for the purpose for which it was intended (Caplen, 1969; Shankaranarayanan & Cai, 2005; Waddell & Stewart, 2008), flexibility can be seen as a quality aspect for products that cannot operate without this attribute. Flexibility can be defined as the extent to which a system can handle changes to data and data combinations without affecting other data quality characteristics. Other data quality aspects like timeliness, validity, consistency, completeness and accuracy, are in direct conflict with flexibility. From the research done specifically on scheduling or timetabling systems, a system without flexibility is not completely adequate for the purposes for which it was created (Bazargan-Lari, 2004; Deris et al., 1997; Sabin & Winter, 1986; Wright, 1996). Therefore it seems appropriate to include flexibility as a data quality aspect since this research looks specifically at a timetable scenario.

The flight scheduling system had to be able to handle changes on a daily basis, making flexibility one of the key attributes of a quality system (Bazargan-Lari, 2004). In a school timetabling system, teacher preferences were an important objective, making flexibility a qualitative aspect of the final product (Wright, 1996). The ever-changing parameters in educational institutions also make flexibility an attribute needed over and above standard solutions (Sabin & Winter, 1986). Therefore a

balance needs to be found within timetables to cater for flexibility, while retaining the other aspects of data quality like timeliness, validity, consistency, completeness and accuracy.

3.2.7 Completeness

Completeness of data has been expressed as the extent to which the required data elements are collected from a large enough section of the target population (Stephens, 2007). It has been measured as the percentage of occurrences of a source element that contain values that are considered to be not missing (Smith & Adelman, 2006) or the representation of a data value is the same in all cases (Wang et al., 1995). These two definitions differ in that the first can be considered as structural or context-dependant completeness, and the second as content or context-independent completeness, depending on whether the data is being used for decision making or not (Shankaranarayanan & Cai, 2005). Shankaranarayan et al. (2003) view completeness in a much broader context, where an information product (IP) is considered, whether it is a single data element, or a combination of entities, to be complete if all the data elements required to create it are available. These data elements may come from different sources and be part of different entities. Therefore data can be considered complete if all the values or entities needed to interpret the end product or entity are available. This can stretch across functional boundaries and systems within an organisation.

Data can only support business requirements if it is complete. If data is not able to support business requirements, then projects within the business have a high risk of failure regardless of the amount of time and money invested in them (Trillium Software, 2006).

3.2.8 Ease of use

How easily users can access data, how user-friendly the software that enables them to do this is and how clear the data definitions and access procedures are, determine ease-of-use as a quality dimension (Stephens, 2007). Quality can be regarded as the

perceptions built up from our own knowledge, thinking and experiences, hence the approach to quality has shifted from focussing primarily on the dimensions of a product, to a customer's total experience and satisfaction with that product (Waddell & Stewart, 2008). These customer expectations are most often met through their experience with the end result of a product, like how easily can they access their data, whether it is a pleasant experience or not, and whether the data provided is of value and quality to them. Ease of use goes a long way to making data usable, regardless of the quality thereof in the underlying systems.

3.2.9 Accountability

"Ultimately, data and its level of quality must be supported by many people in the company, not just IT" (Trillium Software, 2006, p. 5). In their report on quality data-intensive projects, Trillium Software (2006) stress the importance of successful interpretation and treatment of data through the use of proper syntax involving data qualities like accuracy and completeness, as well as the use of proper context, or the meaning and use of the data, which can only be interpreted by the business owners of the data. About 80% of all data integration projects run over schedule or budget due to the lack of knowledge about the source data (Healy, 2005). This happens when people move on, neglecting to leave behind proper documentation or to follow the correct hand-over procedures, leaving no specific individual accountable for the source data.

Data owners should be primarily responsible for determining the business value of data instead of relying on the system integrators (Vosburg & Kumar, 2001). This places the accountability for the quality of the data at the feet of the business users, making them more likely to buy into processes that will ensure ultimate data quality.

3.2.10 Accessibility

When data is available to those who require it, when they need it, then the data is said to be accessible (National Division Diabetes Program, 2003). As organisations expand, data is often spread across functional, product and geographical boundaries. As a result, data errors have increased in the applications integrating these cross-

boundary systems (Wang et al., 1995). To add to this, the volume of data increases tremendously, and is often stored in too many places for an individual to grasp (Adams, 2001). All this contributes to difficulty in accessing data by those who need it in a timely fashion. As data is stored in various data sources, it is often merged into data warehouses or data marts, and only refreshed periodically. The data is often not refreshed often enough for decision makers, causing knowledge to be lost (Fang & Rachamadugu, 2009). These are all contributing factors to lack of accessibility of data. If data cannot be accessed then the quality thereof is of no effect. If quality is ultimately measured as meeting the requirements for which it was intended (Caplen, 1969), then accessibility is a large part of the aspects of data quality.

The following paragraphs discuss the more extrinsic qualities of data based on the output resulting from the information systems (Stylianou & Kumar, 2000). Or as Raghunathan (1999, p.277) puts it, "the quality of the output depends on the quality of the inputs and the quality of the process that transforms the inputs to the output".

3.2.11 Data Interpretation

Data interpretation asks the question: What problem has the information solved for you? The answer may not conform to the original requirement that were specified, often by other business areas. The lack of a common and shared understanding of the value and use of data between those entering the data and those using the data for different tasks can lead to dirty data (Vosburg & Kumar, 2001). Databases change over time. Information is added, deleted and updated, structures and relationships within the database may change and fields are altered to meet changing business needs. Databases that have been designed for one purpose are then also shared with other areas (Healy, 2005). Therefore the interpretation of the data output from the system ends up meaning something different to different people with different goals in mind. Involving subject matter experts from the various business areas involved in the data quality process, is an essential step necessary for successful data quality, as the interpretation and treatment of data is very context specific (Trillium Software, 2006).

As shown in the study of the impact of information quality on the quality of decision-makers decision quality, the quality of the decisions made does not always improve with higher data quality aspects due to a lack of knowledge about the relationships among data elements or problem variables (Raghunathan, 1999). The interpretation of data as an end result of an information system can therefore cause confusion as information can be used for a different purpose than that for which it was originally intended.

3.2.12 Ownership

Vosburg & Kumar (2001) recognise that only senior management can recognise data and the processes that produce that data, as a basic corporate asset. Therefore it is management's responsibility to ensure that all employees understand that the responsibility for the quality of data lies with them. Data owners should be primarily responsible for determining the business value of their data. Often geographical distances and functional barriers add complexity to the issues surrounding data quality. By having each functional area responsible for their sub-set of data, the business requirements of that data will be defined and they should take responsibility for the quality of the data under their ownership.

Unfortunately something that is often overlooked by this approach, is that business users from different functional areas also make use of the same data, but often from different applications. These end-users could also be perceived as owning the information generated from the system, so should therefore be involved in the processes set up for ensuring data quality, as each data owner will interpret it according to their needs (Trillium Software, 2006).

3.2.13 Uniform technology

Most organisations are made up of heterogeneous systems, each having their own data definitions and accuracy levels (IBM, 2007). Each source may be made up of its own standards and quality aspects, as well as making use of different technologies. It therefore may be necessary to establish a set of standards that all source systems can

conform to in order to produce consistent results from the data used (Trillium Software, 2006). It is important for data to be consistent across storage mediums, and that the users of the data understand the meaning of the data within the context of the business. To ensure the integrity of the data, a systematic and consistent approach to processing, storage, sharing, manipulation and reporting of data is needed across all source technologies. By integrating several business functions onto a single system, means that all data is available from one source which holds tremendous potential for consistent reporting (Vosburg & Kumar, 2001).

The dangers of using multiple sources are that the more databases that are shared and modified to meet changing business needs, the greater is the risk of the degradation of the information stored within them, causing major risks when data needs to be integrated across systems (Healy, 2005). This is cited as being one of the reasons that companies land up with dirty data by having disparate data stores across departmental and organisational boundaries. By using uniform technology, like a central ERP system, the data quality problems caused by disparate data stores can be overcome (Vosburg & Kumar, 2001).

Although most references focus on data stores, the more integration and application steps that data is transformed through before arriving at the end-user, would also cause more margin for error and reduce the quality and reliability of the data.

3.2.14 Uniform procedures

Most organisations are collecting and using information across the whole enterprise to be used for decision-making (Healy, 2005; IBM, 2007; Shankaranarayanan & Cai, 2005). For this reason the data quality of that information should be consistent across the organisation. Waddell & Stewart (2008) make the supposition that information management can be incorporated into organisations via processes or systems using a quality culture. To do this, procedures including systematic safeguards and end-user training programs to prevent dirty-data in systems should be introduced, and it should be emphasized that maintaining data quality is an on-going process in which everyone needs to play an active role (Vosburg & Kumar, 2001). Uniform procedures should

standardise the process for capturing data, as well as standardising on the delivery mode of that information to ensure that the data remains of a high quality and is being used for what it was intended.

3.2.15 Common terminology

A data field can have a title meaning something different to those entering the data to those using the data, depending on their interpretation of it (Vosburg & Kumar, 2001). A "set of standards" as mentioned above according to Trillium Software (2006), is not only necessary for multiple data sources, but also for consistent terminology across functional or organisational boundaries. Therefore all users should have a common understanding of the meaning of the data within the context of the business across all business areas.

3.3 Decision Systems

The reason this section has been included, is because decision systems, knowledge management systems, data mining and data warehouses contribute to the cleanliness of data (Vosburg & Kumar, 2001). Systems like these are useful to highlight data quality issues and help identify erroneous data.

As an example, data mining, although it can access many different kinds of underlying technologies, has also run into the problem of no consistency in the data being collected because different parts of the company were collecting different sets of data, causing the company to have difficulty finding patterns that could be relied upon. By standardizing how and what data was collected, and organizing it into a data warehouse with data analysis software, they were able to produce results. A data warehouse is a collection of data that has been extracted from operational databases and then cleaned to remove redundant data and bring in any additional data that was deemed needed (Adams, L. 2001). Therefore the process and consistency are important for the quality and usability of the data.

Decision support systems require efficient data quality management as large data volumes, distributed data sources, and multiple stakeholders are involved. Decision

makers have no control over the number and distribution of data sources, making it difficult to guarantee data quality (Shankaranarayan et al., 2003).

Timetable optimisation systems can be seen as decision support systems. It decides when and where what class will be presented. The decision maker at institutions would depend on whether a centralised or decentralised timetabling solution was in place, as well as on the quality of data comprising the timetabling system.

3.4 Timetable Data Quality Characteristics

A timetable is essentially a system that makes intensive use of data from other, often disparate, data sources. In the same way that a Knowledge management system (Fang & Rachamadugu, 2009; Waddell & Stewart, 2008), or a decision support system (Shankaranarayanan & Cai, 2005; Shankaranarayan et al., 2003) would require quality information, so does a timetabling system. The same hindrances are encountered in all these systems. For example, the qualities of the underlying data affect the quality of the information provided, data potentially needs to be integrated and refreshed at some point in time, and the procedures followed for data entry in the various underlying data sources are often not standardized.

Timetables have added complexities as the end-user requirements, or governing parameters or constraints, are usually diverse and non-complimentary, causing an optimized solution difficult to achieve. Flexibility, centralized versus decentralized timetables and accommodating a wide range of subjects, classes, students and staff into a “best-fit” scenario are examples of these unique complexities (Bazargan-Lari, 2004; Boland et al., 2008; Deris et al., 1997; Wright, 1996).

The data required for timetables also comes from different parts of the organization, most of which maintain their own data with different strategic objectives in mind. Data owners of the timetable have specific needs from the timetable at the end of the process, so the involvement of business users in the process is important for ultimate data quality. In other words, each data owner will interpret it according to their needs. Ultimately data and its level of quality must be supported by many people in the

company, not just IT (Trillium Software, 2006). Therefore ownership and accountability will have a large influence on the success or failure of the timetabling process in larger organizations with separate business areas and many stakeholders. At the NMMU, roles and responsibilities, processes, and having data stored in one place have been identified by the Central Timetabling Office (CTO) as important elements to manage the timetable (Erasmus, 2008).

There is also wide variation in the terminology used between various timetabling systems. In academic timetabling, you have “lessons”, also referred to as “sessions” or “time intervals”, “rooms” or “locations”, “programs” or “subject selections” or “curriculum”, “blocks” or “subsets of classes”, and “teachers”, “lecturers” or “instructors” (Bazargan-Lari, 2004; Boland et al., 2008; Deris et al., 1997; Sabin & Winter, 1986; Wright, 1996), to name a few of the terminologies used. This is just within the timetabling area, regardless of the differences in terms used across functional areas.

It has also been noted that automated, centralized timetables offer better quality and more timely information for instructors than decentralized timetables (Deris et al., 1997; Sabin & Winter, 1986), although de-centralized timetables offer more flexibility (Bazargan-Lari, 2004).

Universities also have a higher complexity of timetabling due to more students, classes and programs offered, as well as non-uniform room capacities which are more tightly constrained (Boland et al., 2008). These complexities make it imperative that the data upon which the timetable is based is error-free, and that the processes that are followed are standardized to prevent quality issues arising as discussed in the previous section.

Quality is ultimately determined by whether the requirements of the end product have been met (Caplen, 1969; Waddell & Stewart, 2008), therefore the focus needs to be on what requirements are specifically for timetabling. Thus far, qualities such as uniform technology, flexibility, ownership, accountability, common terminology, uniform procedures, timeliness, as well as the more usual data quality aspects like accuracy,

continuity, integrity and completeness are requirements for an error-free, quality timetabling system.

3.5 Conclusion

From this study it can be seen that data quality does not only pertain to fields in a data source, but relates to the complete customer experience. Data quality aspects cannot be looked at in isolation from the context in which they will be used, and all stakeholders involved with the data, from entry to delivery, need to be included in the data quality process.

Considering that quality is measured by whether it is satisfactory for the purpose for which it was intended or whether it conforms to specification, the most likely qualities in a timetable will have to be identified. The main data quality characteristics expected in a timetabling system according to the literature study above would be flexibility, so that it can suit the various needs of the stakeholders and users, ownership or accountability for the underlying data sources, and consistency, especially with regards to terminology used. The main quality aspects that seem pertinent to all systems would also therefore relate to timetable data quality, namely accuracy, timeliness and completeness.

Chapter 4: Research Design

4.1 Introduction

This chapter, details the research methodology, and the techniques used for data collection employed in this study with justification for choosing the method.

4.2 Research Design

There are many definitions of research design, for example, Mouton (2006) defines research design as a plan or blueprint of how one intents conducting research. Mouton (2006) further explains that a research design focuses on the end product, point of departure and focuses on the logic of research.

There are two types of research design namely; qualitative and quantitative.

- **Quantitative research** is concerned with quantifying a relationship or comparing two or more groups. The aim is often conducted to identify a cause effect relationship.
- **Qualitative research** is concerned with studying objects in their natural settings. A qualitative researcher attempts to interpret a phenomenon based on explanations that people bring to them.

For the purpose of this study a qualitative research approach was adopted. Qualitative evaluation approaches involve the use of predominantly qualitative methods to describe and evaluate the performance of programs in their natural settings, focusing on the process of implementation rather than on outcomes (Mouton, 2006). Baker (1988) states that qualitative research attempts to understand how an entire social unit such a group, organization or community operates in its own terms.
Qualitative research consists of a variety of approaches from which to interpret research. The following are the commonly used research designs:

- Case study
- Enthography
- Phenomenological study

- Grounded theory

For the purpose of this study, case study is the selected method, hence discussed in detail below.

4.2.1 Case Study

A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context (Yin, 2003). There are two types of case study design (Yin, 2003).

- **Single case study** is used to represent a unique single case.
- **Multiple case study** contains more than a single case.

As the focus of this research is on the NMMU only, a single case study approach was used.

4.2.2 Case Study Data Collection

Data for case studies can be from many sources of evidence such as interviews, surveys, document analysis, direct observation, focus group, questionnaire among others (Yin, 2003; Cooper & Schindler, 2006).
Questionnaires and interviews combined with evidence from literature were chosen for the purpose of this study. These techniques are discussed below.

4.2.3 Interviews

An interview is a technique which involves direct personal contact with the participant who is asked to answer questions relating to the research problem (Bless & Higson-Smith, 2000). According to Yin (2003) in indepth interviews, the researcher initiates a dialog with a real person and engages the interviewee as a human being not as a study subject. Therefore, the interviewer does not utilise a structured interview, but rather constructs a guide of open-ended questions. The principle advantage of open interview schedule format is that it does not suggest the terms which respondents should answer a question (Babbie, 2005). Interviews were used to determine the current busines processes of the NMMU timetable.

4.2.4 Questionnaires

The main aim of the questionnaire is to determine the quality aspects most pertinent to the NMMU, as well as to identify probable causes for bad data quality within the timetable. For this study, the research questionnaire used both closed-ended and open-ended questions in which the respondents could choose one of several options. Closed-ended questions have the advantage over open-ended ones in that they are quicker and easier to answer.

4.2.5 Participant Sampling

The basic idea of sampling is that by selecting some of the elements in a population, conclusions of the entire population is drawn (Cooper & Schindler, 2006). Cooper and Schindler (2006) further explains that the sample must be valid and its validity depends on accuracy and precision.

There are two types of sampling namely, probability sampling and nonprobability sampling Babbie (2005).

- **Probability sampling** - Probability sampling is based on randomisation (Babbie, 2005).
- **Non-probalility sampling** - Non-probability sampling refers to the case where the probabilty of including each element of the population in a sample is unknown (Bless & Higson-Smith, 2000)

For the purpose of this study non-probability sampling techniques were used. There are various types of non-probability sampling namely purposive, qouta and target (Cooper & Schindler, 2006).

4.2.6 Purposive Sampling

This type of sampling is based entirely on the judgment of the researcher. There are two types of purposive sampling; judgement and qouta sampling.

- **Judgement sampling** occurs when a researcher selects sample that conform a certain criteria (Cooper & Schindler, 2006).
- The purpose of **qouta sampling** is to draw sample that have same proportions of characteristics as the population and represents the population as such (Bless & Higson-Smith, 2000).

For the purpose of this study judgemental sampling technique was used.

4.2.7 Purposive Data Collection

Questionnaires were distributed to selected staff members from each faculty at the NMMU who were responsible or involved with the creation of the timetable, as well as to members of the Central Timetable Committee and administrative staff involved in maintaining composite data sources used by the Central Timetable Office. The questionnaire was confidential and anonymous. Data analyses included descriptive statistics and simple percentage and bar charts to understand the importance of various data quality aspects and their relationship to one another.

The data gathered was captured using Microsoft SharePoint to which selected staff members had access. This was then exported into a basic Microsoft Excel worksheet and then descriptively analysed to determine the data quality aspects most important to the NMMU timetabling process and what the most probable causes for bad timetable quality were.

4.2.8 Terms of Assessment for the Questionnaire

Depending on whether staff members are employed as Academic or Administrative staff, their terms of reference, purpose and interpretation of the timetable will differ. Therefore the questionnaire was structured in such a way so as to get the requirements

from both perspectives, as well as what each considered to be the major causes for bad data quality within the NMMU Timetable. Below are the various aspects of data quality identified from other studies discussed in chapter 3 that seem to be the most relevant for the timetable, with a brief explanation of each. The questionnaire will address the two main issues:

a. What are the NMMU's requirements in terms of data quality in the timetable (Figure 4.1)?
b. What are the major causes of bad data quality in the current timetable (Figure 4.2)?

Each data quality aspect can be tied to practical issues surrounding the timetable data and business processes. The main issues addressed by the questionnaire are discussed in this section.

a. NMMU's requirements in terms of data quality in the Timetable

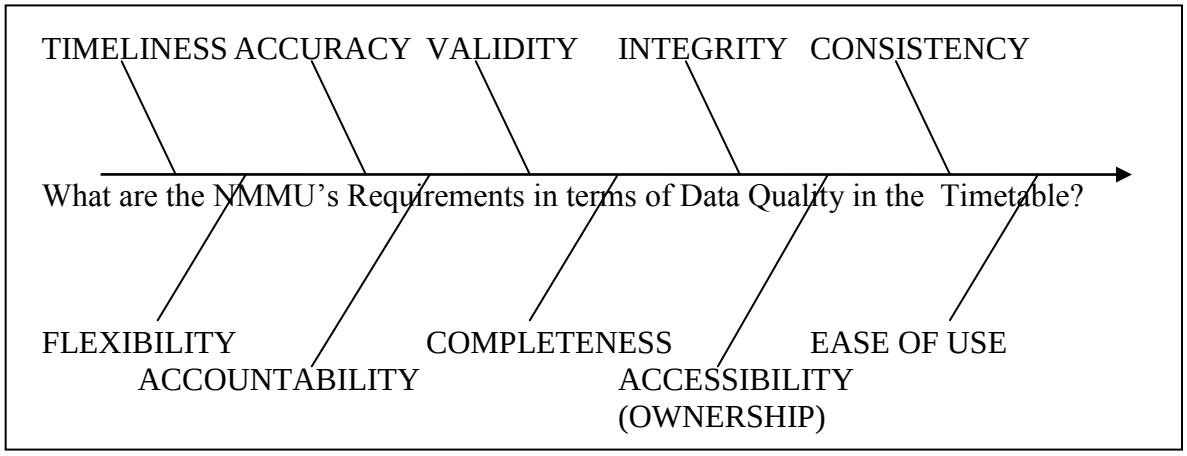

Figure 4.1: Fishbone diagram of Data quality aspects that are required by the NMMU.

Timeliness

Timeliness is about whether data is available when needed and on time to improve business processes (Stephens, 2007). Timeliness can be ascertained by whether the timetable is ready on time, and by whether the data required by the timetable is available on time. What are the main target dates each year for the timetable?

Accuracy

Accuracy depicts whether the timetable can be relied upon to give accurate information. It must be free from significant error (Smith & Adelman, 2006). For example, can the venues listed in the timetable be related to a physical "address" or "classroom"? Are the periods and times thereof correct? Are all modules displayed on the timetable?

Validity

Validity means that data must reflect on actual performance (Stephens, 2007). Does automated optimisation produce valid results?

Integrity

Integrity represents the amount of confidence stakeholders have in the data to make decisions with. Questions that need to be answered relating to integrity would be: Who has access to see or change the timetable? Does all the data used in the timetable come from one source? Who is primarily responsible for the timetable?

Consistency

Quality of data is improved through consistency. In other words, if the same processes are used each year, then these processes can be improved upon, rendering more accurate data. Therefore consistency can be determined by whether the same procedures, definitions, and systems are used across the board at the same time, to collect and collate the timetable data.

Flexibility

Data quality aspects like timeliness and flexibility are in direct conflict with one another. Therefore a balance needs to be found within the timetable to cater for a certain amount of flexibility (e.g. allowing academics to state preferred venues or times), while retaining the other aspects of data quality like timeliness, validity, consistency, completeness and accuracy.

Completeness

Data is complete if all the data elements required to produce the required information are available (Shankaranarayan et al., 2003). As is quite often the case, data has no use if it is not complete. Are all venues and modules represented? Of what use would a timetable without times, be for a student, or how can the timetable be optimised if not all the venues are listed? This also has an impact on timetable reporting to the DoE as space usage.

Ease of Use

Ease of use relates to the total customer experience (Waddell & Stewart, 2008). Even if the timetable has brilliant quality data, it can be rendered useless if it cannot be easily accessed or used. For example, how much of the data can be automatically taken from the system without having to add data manually to produce the timetable?

Accountability

Data owners are primarily responsible for determining the business value of their data (Vosburg & Kumar, 2001). Accountability relates to ownership. Whose responsibility is it to maintain and provide an accurate timetable? Are all the "feeder" data sources maintained by the same section, or will the quality of these systems ultimately have an effect on the end result?

Accessibility

Data is accessible when data is available to those who require it, when they need it (National Division Diabetes Program, 2003). Does everyone have access to that part of the timetable that they need in order to do their job properly? This includes data sources as well as reports.

b. Major causes of bad data quality in the Timetable

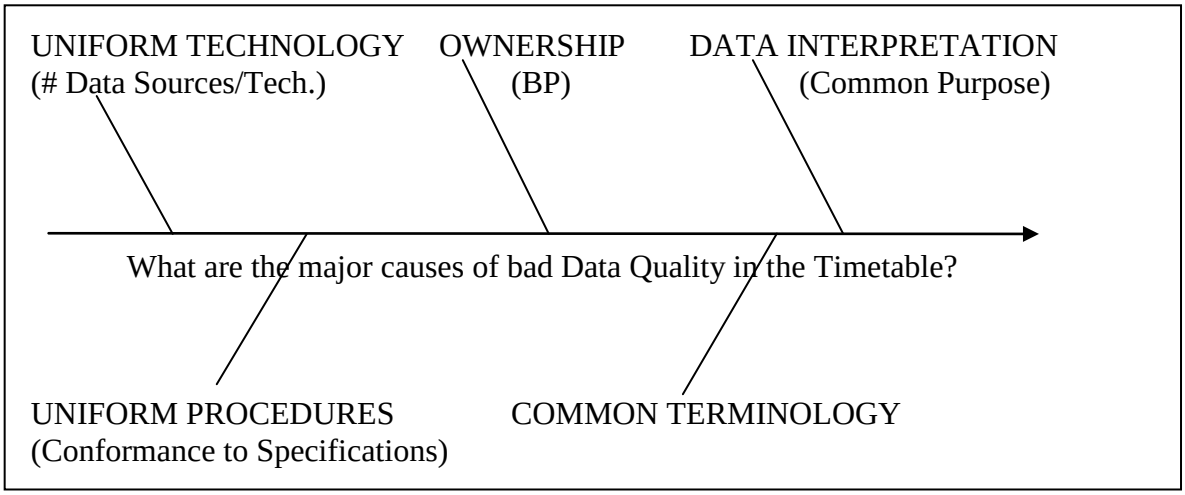

Figure 4.2: Fishbone diagram representing potential causes of bad quality in the NMMU timetable.

Data Interpretation

As stated before, academic staff and administrative staff have different goals in mind when it comes to the timetable. Therefore the data is interpreted in different ways, not only by academic and admin staff, but also possibly between campuses, programs and delivery modes. Data interpretation asks the question: What problem has the information solved for you? Does the end result conform to specification?

Ownership

By various departments owning different sections of data required by the timetable, it means that data quality can vary between sections, and ultimately have an impact on the final timetable produced.

Uniform Technology

Does all the data come from the same database, or is it manipulated along the way by other programs or systems or manually? The more interfaces the data has to go through before reaching the end result, causes there to be more margin for error, thereby reducing the quality of the data. It may be necessary to establish a set of standards that all source systems must conform to (Trillium Software, 2006).

Uniform Procedures

Does everyone follow the same process for capturing data, or is there more than one way to do the job? On the other end of the process, is there one point of access, or is the same information delivered in various places, possibly for different purposes, opening gaps for erroneous interpretation of the data?

Common Terminology

Data fields can have different meanings to those entering the data to those using the data depending on their interpretation of it (Vosburg & Kumar, 2001). Is it possible for headings to be misleading regarding the content of the information? Are a uniform set of definitions or formulas being used for the timetable? For example, the building naming conventions?

4.3 Data Analysis

Data analysis consists of examining, categorizing, tabulating and testing of qualitative evidence to address the initial propositions of the study (Yin, 2003). Yin (2003) further states that analyzing a case study involves the use of strategies namely, pattern matching, explanation building, time-series, logic models and cross-case synthesis.
Creswell (2003) and Yin (2003), have comprehensively described analytic manipulations in the analysis and interpretation of qualitative research data and includes:

- Putting information into different arrays;
- Making a matrix of categories and placing the evidence within such categories;
- Creating data displays – flowcharts and other graphics for examining the data;
- Tabulating the frequency of different events;
- Examining the complexity of such tabulations and their relationships by calculating second order such as means and variance and
- Putting information in chronological order or using some other temporal scheme.

Creating data displays and tabulating the frequency of events were mainly used in the case study in order to present a qualitative analysis of the collected information.

4.4 Conclusions

The research methodology used in this study followed a qualitative research approach using a single case study research design. Data collection for the case study used interviews, a questionnaire and literature studies.

The questionnaire used non-probability, judgement sampling, and was mainly aimed at determining the data quality aspects needed by the NMMU timetable process, as well as those aspects causing bad timetable quality. Interviews were used to determine the current timetable business processes in place.

Chapter 5: Case Study

5.1 Introduction

In this chapter, the NMMU timetable will be used as a case study as to how aspects of data quality affect its business processes, and what the current situation is at the NMMU regarding the timetable. This chapter will be structured into five sections. The background of the NMMU timetable data, where it is located and what state it is in and how it impacts on the timetable will be covered first. The second section will deal with the NMMU timetable business processes as per research question 1 in Figure 1.1, what is currently in place, and how it relates to the literature study done on business processes and quality management best practices in chapter 2, as well as to data quality aspects as discussed in Chapter 3. The third section will investigate what the actual data qualities required by the timetable are and which are most relevant to the NMMU timetable as per research question 2 in Figure 1.1. The fourth section investigates the causes for the current quality of the NMMU timetable in relation to research question 3 in Figure 1.1. Section five identifies the shortcomings of the NMMU timetable process and what future preventative measures can be put in place according to research question 4 in Figure 1.1.

The main aim of this section is therefore to present the current NMMU timetabling business processes, to determine the most relevant data quality dimensions for the NMMU timetable, to discover the most probable causes for bad timetable quality, and to find the most appropriate and best suited method for managing data quality within timetables for future use.

No timetable optimization techniques are discussed as it is assumed that the current timetable optimization algorithms are working optimally within those timetabling systems using market related timetable technology.

The timetable is central to the smooth operation of the university. If a student and lecturer do not have the same correct information regarding lecture venues, subjects or class times, then confusion results and the ultimate objectives of the university are not met i.e. education. Therefore the timetable is key to achieving the main strategic

objectives of the university, and a bad perception of the timetable quality would affect the number of student registrations, and ultimately cost the university financially. This will directly affect the NMMU's objectives of people-centeredness for fostering a supportive and enabling environment that will attract and retain students (Nelson Mandela Metropolitan University, 2008).

5.2 NMMU Timetable Data

5.2.1 Background

The background of the NMMU timetable originates with the merger of three old educational institutions, the University of Port Elizabeth (UPE), Port Elizabeth Technikon (PET), and Vista University (Vista). Each institution had their own way of generating a timetable for their specific purposes, even though all three institutions ran the Integrated Tertiary Software (ITS) ERP system. When Vista and UPE merged, Vista simply took over UPE's process, which was manually setting up the timetable in ITS from where it was accessed. At that time, PET was using another product that was based on a SQL Server database called "Celcat" which only interfaced with ITS to either retrieve or upload information. This peripheral system allowed for flexibility and worked well with a structured curriculum. However, none of this information was captured or loaded into the ITS timetable module. When PET and UPE merged, the PET SQL Server based timetable was discontinued so that the whole curriculum timetable could be captured onto ITS in a central, integrated location which catered for the university type unstructured curriculum as well. The merger also merged the three institution's Oracle databases into one. Although as much as possible alignment of data was done, there were still some data inconsistencies from the legacy systems, like duplicated space data, and no timetable history data for the PET. As a merged institution, the NMMU purchased a new peripheral product for generating the timetable which was meant to interface seamlessly with ITS and had its own optimizer for the generation of optimal timetables. On implementation however, the system was found to have basic differences with the way in which the NMMU captured their data into ITS, as well as having to contend with the universities' legacy unstructured curriculum, resulting in the timetable having to be manually captured into ITS for the first year after the merge. Because of the delays in getting the

timetable out, this had the effect of each department making their own backup arrangements as far as their own timetable went, and only consulting with the CTO for venue bookings.

5.2.2 Technology

In order to discuss the data related to the timetable, it would be beneficial to explain the technology used for the NMMU timetable. The ERP system that the NMMU uses is the ITS system which was originally designed with educational institutions in mind. ITS is an integrated system that contains modules for student systems including student applications, registrations, student debtors, as well as an academic structure, lecture timetable, exam timetable, a cooperative education system and student bursary and loans system. In addition to this it also caters for Human Resources (HR), payroll and finance, as well as resource systems like assets and an infrastructure system maintaining all buildings, campuses, lands, rooms and associated attributes. The infrastructure system will be referred to as the "Space" system from here on.

The ITS database is an Oracle relational database running on a Unix operating system. In addition to the ERP system, a Microsoft SharePoint document management system is in place which allows users to store and share any kind of document, as well as create small applications for capturing information. SharePoint is not integrated with ITS in any way. Other peripheral systems that do integrate with the ERP system run on SQL Server databases. One such system is the new timetabling system known as "Abacus O!Timetable", hereafter referred to as "O!Time". O!Time comprises of its own SQL Server database, a timetable generation and optimization tool, and a web interface for querying, updating and viewing the timetable generated. O!Time is also capable of generating an exam timetable. In order for O!Time to work, it needs the required information to be transferred from ITS. Other information not available in ITS can be manually entered into O!Time itself. Once the timetable has been automatically generated, it is then loaded back into ITS.

The NMMU also provides a web portal from where staff and students can access certain information, including the timetable. In addition to this, ITS provides a student and lecture on-line system (iEnabler) that offers the same information.

ITS has the capacity to store the timetable and do validations against the academic structure and HR system when it is manually entered, but is not capable of automatically generating a timetable itself. Various timetable reports can be drawn from ITS to give to students either at registration or on request.

5.2.3 Data Sources

There are three main data sources as determined above. ITS using Oracle, O!Time using a SQL Server database, and the SharePoint document management system within which any data relevant to the timetable can be stored in any format, like MS Excel or Word.

Within ITS, various data is accessed to produce the timetable, including Space data (venues, capacities), HR data (lecturers), Academic Structure data (curriculum), Student data (student registrations per module), and control data like days per week, sessions per day, length of sessions and cycles. This data is extracted and then imported into O!Time. The O!Time timetable generator requires additional data that is either not stored in ITS, or is required in a different format that is not compatible with ITS. Data of this kind includes Module constraints, Global constraints, Venue Tags, and module/offering type/class type groupings. These need to be manually set up in O!Time. The information in O!Time may be manually updated to clarify the output generated, for example venue descriptions. Certain constraints like lecturer preferences and open sessions can only be obtained from input by the stakeholders involved.

So far, the sources of the input data have been described. Sources from where the generated timetable or ITS timetable can be accessed are O!Time, ITS, the NMMU web portal, the Student Kiosk system, ITS iEnabler, SharePoint and Excel spreadsheets. These sources represent the information derived from the data elements

mentioned above, and also contribute to the quality of the timetable. This data is usually provided in the form of a report.

5.2.4 Data Quality Aspects of the NMMU Timetable

For the timetable to be generated without problems and to produce an optimized, suitable timetable as output, it is important that quality data be used, and that quality aspects pertaining to quality control be adhered to. The timetable must be accurate, complete and timely. In order to achieve this, the data provided to it must be valid, and the systems which manipulate this data must operate with integrity on a consistent basis. The timetable produced should be adaptable to changes (flexible), easy to use and accessible. To ensure that the timetable contains these attributes, accountability and data ownership are essential.

As mentioned in Chapter 3, other factors that are not directly data related can negatively affect the perception and trust of the timetable quality, like the interpretation of data, ownership, uniform technologies and procedures, and failure to use a common terminology throughout the process when setting up or interpreting the timetable.

The timetable generation tool can be seen as decision-system as it “decides” how the timetable will be structured by making use of the data that is provided.

5.3 NMMU Timetable Business Processes

5.3.1 Current Timetable Business Processes

It is important that the requirements of the timetable are in alignment with the institutions strategy and objectives. The NMMU’s values and principles incorporate people-centeredness, excellence and integrity amongst others. It is one of the university’s commitments to have institution-wide quality management and continuous improvement, which will therefore need to be an integral part of the timetable process. Service excellence, offering a comprehensive range of academic programs, and conducting activities with integrity in an accountable and transparent

manner (Nelson Mandela Metropolitan University, 2008) are all part of the NMMU's objectives, and will therefore have to be taken into consideration with the timetable business process, and the timetable will have to somehow cater for the comprehensive range of academic programs on offer.

The NMMU requires a central timetable that integrates with the ERP system to prevent problems like the double booking of venues, and so that all programs offered at the NMMU can fit into the space and time available. Both space and time are constraints at the NMMU. Therefore the programs offered need to be closely monitored and controlled so that the situation does not arise where a module is offered to students, but no appropriate venues are available. For this reason all programs to be offered at the NMMU are approved via the Academic Planning and Quality Committee (APQC), who then needs to be able to validate against the central timetable to discover whether space and time slots are available before introducing the programs to the curriculum. This is one of the main reasons a centrally controlled timetables is necessary.

The NMMU timetable process is currently managed by the CTO. They are responsible for collecting all the data required for the timetable, and providing a workable timetable in sufficient time for registration. However, they are not the owners of the data which is maintained by other business units upon which the timetable relies, for example, the Space system data, HR data, the Academic Structure and Student Registrations. The Space data is owned by the Technical Services department, HR data by the HR department, and the Academic Structure and Student registration data by the Academic Administration department. As can be seen in Figure 5.1, there are numerous business areas that are required to give input to the CTO before the timetable can be generated.

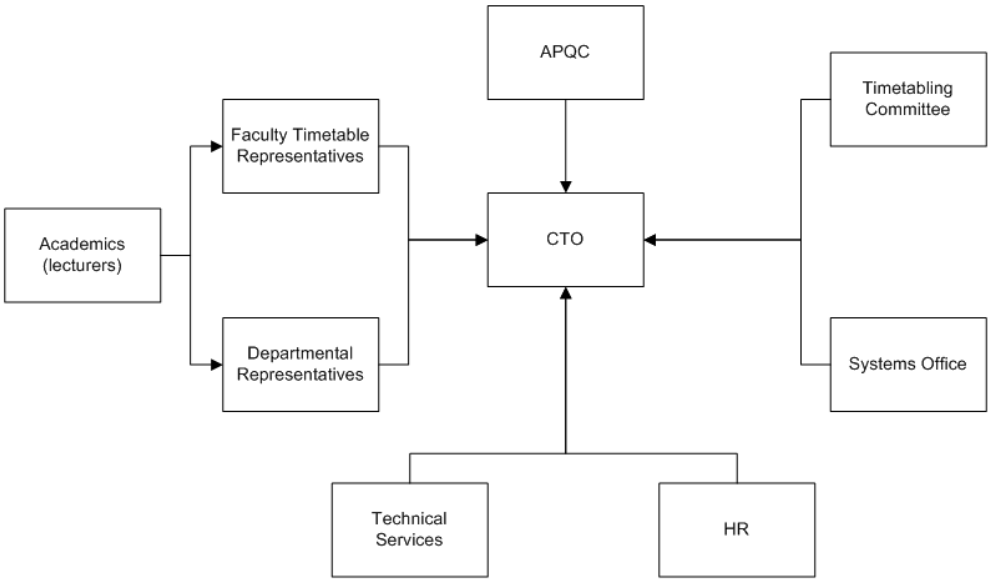

Figure 5.1: Centralized Lecture Timetable Context Diagram.

The current timetable process is depicted in Figure 5.2. This diagram represents a sequential flow of processes, and the data sources containing the relevant data inputs are represented on the left hand side of the diagram, and the data sources written to or documentation and reports produced, on the right hand side as outputs. Notice that the CTO is simply used to book the venues which results in a minimum of two sets of timetable sources, one in ITS, and others generated by the individual departments.

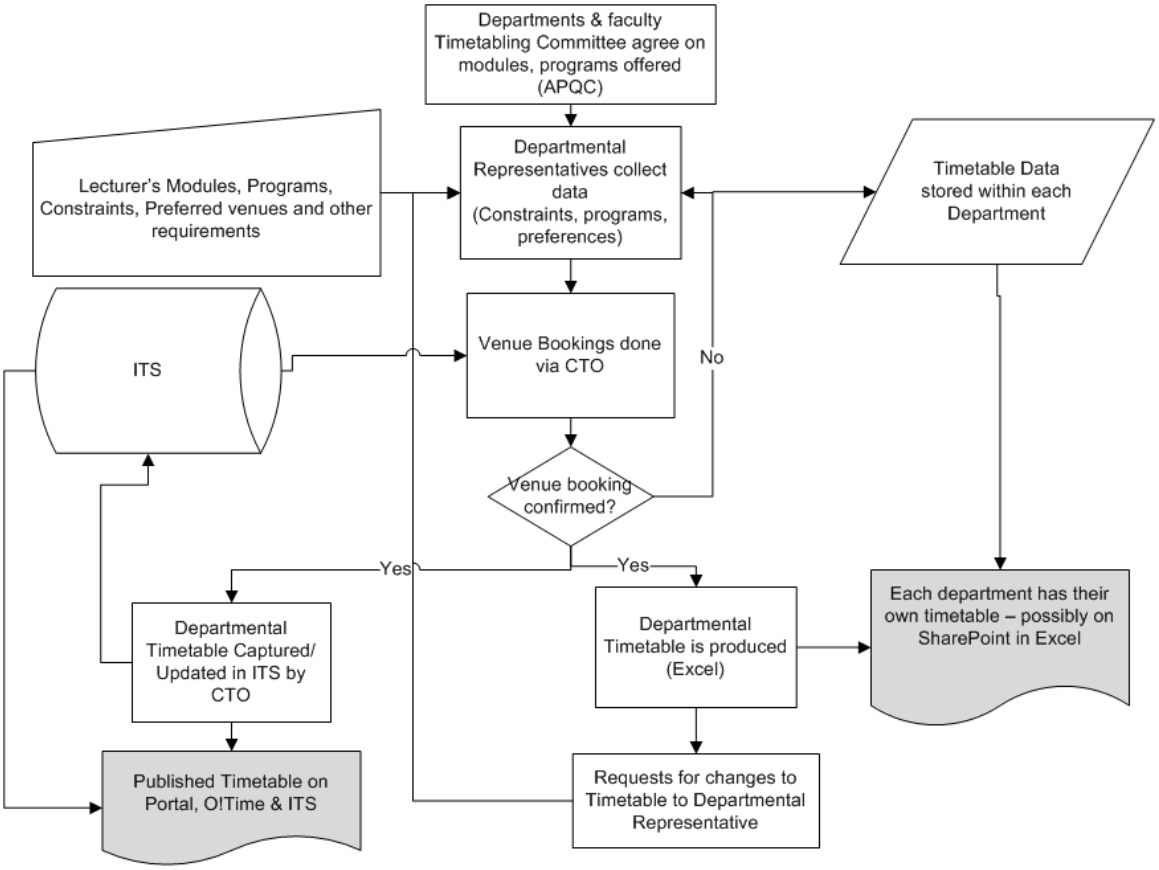

Figure 5.2: Current Departmental Lecture Timetable Business Process.

The CTO was in the process of implementing a timetable, or Facilities Management policy, to streamline the timetabling process at the time of this analysis (Erasmus, 2008). The process they are aiming towards is represented in Figure 5.3. Notice that this process contains more inputs from all the stakeholders involved, and therefore more validations. It also makes use of O!Time as the main source for generating an optimized timetable as this allows for simulating a timetable under difference scenarios, hence the extra steps in importing the required data from ITS into O!Time.

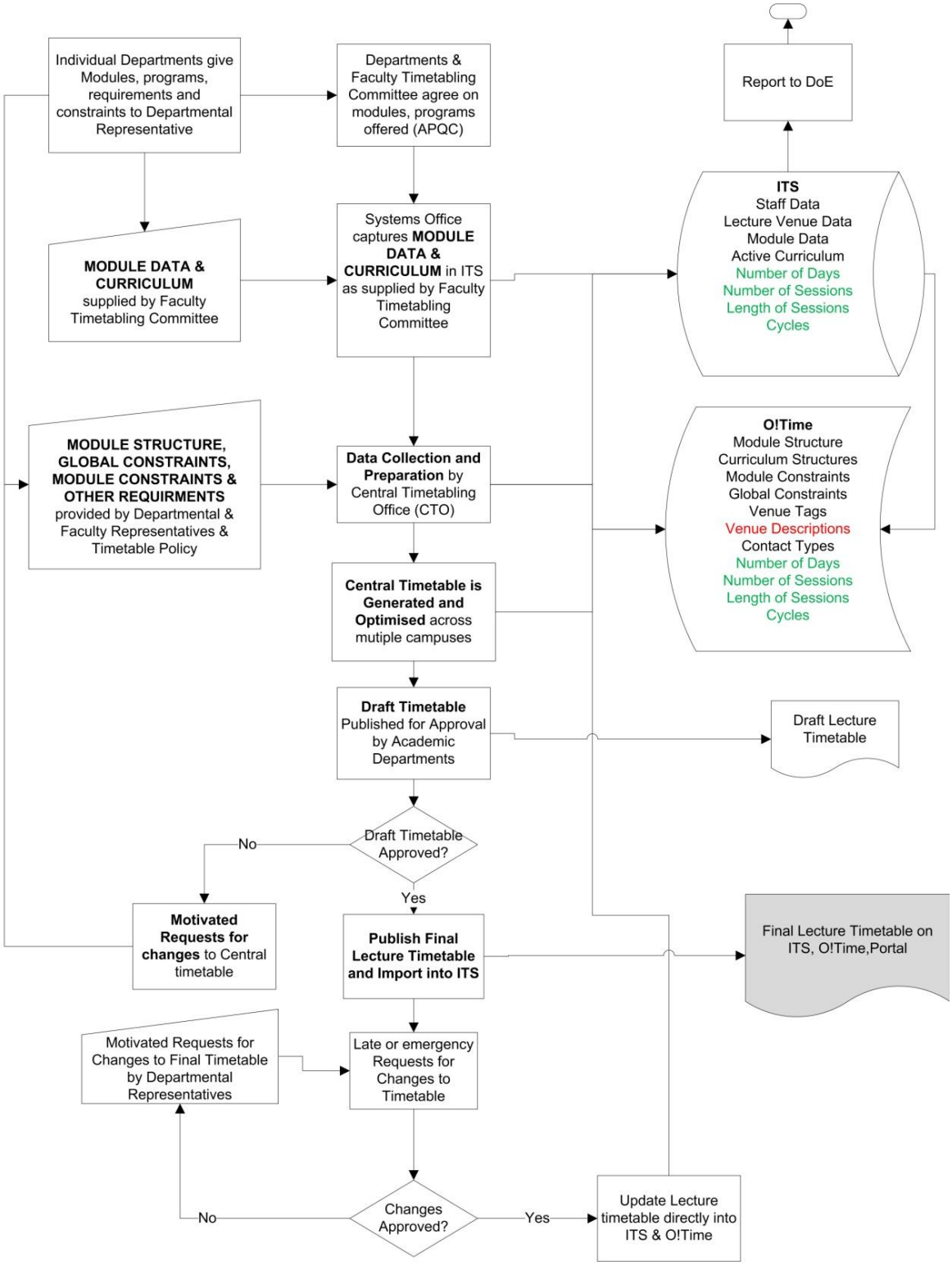

Figure 5.3: Current Centralized Lecture Timetable Business Process.

Note that there is only one source for the final timetable. As yet there are no quality controls or measurements in place on the timetable process, or the "feeder" data

systems. Accuracy and completeness are dependent on the people manually entering and updating these data sources.

There is also no change control system in place for late curriculum structure changes, and the entire generation and optimization procedure has to be rerun in order to determine whether the timetable has the capacity available to cater for a new academic program. This reduces the timeliness and flexibility of the timetable process.

TQM involves top management support and quality controls at each step in the process. ISO 9001 suggests top management be responsible for the communication and review of all the quality requirements within a process. Six Sigma would not necessarily be appropriate for the timetable as the volume of data is relatively small for the extent of statistical analysis involved for Six Sigma, and the timetable is only generated once or twice a year and not on a continual basis. This suggests that one of the simpler more practical approaches to quality management be applied for the timetabling process, like IPMAP or the Quality Cycle.

5.3.2 Characteristics and Constraints Specific to the NMMU Timetable

The situation at the NMMU is unique compared to the universities used in other timetable studies (Boland et al., 2008; Deris et al., 1997; Sabin & Winter, 1986) in that it is spread over multiple campuses. Certain modules can be offered on more than one campus. This makes it crucial that a single central timetable is generated to prevent lecturers from being expected to be two places at one time. Lecturers also need to be able to view their timetable across all campuses. This makes the optimization of the generated timetable very difficult to accomplish.

Another unique feature experienced at the NMMU is that different time-slots and lecture period lengths were used on different campuses. This was a pre-merger situation that carried over into the new institution. This shows no consistency over campuses and reduces the quality of the timetable dramatically.

For the past year, each department has sets up their own timetable in Excel and simply confirmed with CTO about venue availability. CTO then captured this data into ITS. If there is insufficient communication, then the data does not reach ITS and students do not get the correct timetable, resulting in doubly booked venues and lecture clashes. This points out the need for a place where lecturers can communicate directly with CTO to maintain the integrity of the timetable system.

For changes and requirements, or constraints, to the timetable, lecturers currently have to work through their Faculty representative which tends to have too much red tape, and therefore takes too long for the timetable to be changed in time before the students receive it. This part of the business process has been problematic for academics and affects the timeliness of the timetable.

Communication between individual departments in a de-centralized timetable scenario (as depicted in the before business process in Figure 5.2) is scarce, so the CTO ends up being the central point for venue bookings and clashes. If there is insufficient communication with the CTO, then clashes occur. This also raises the question whether all departments use the CTO to book venues?

Another point that is relevant to the NMMU timetabling process is dedicated venues. These are venues that serve a particular purpose, like art rooms, chemistry laboratories and the like, and pose constraints on the timetable as they can only be used for certain subjects and class types. Multiple venues also exist where more than one venue (like computer labs) are needed for one subject due to the size of the classes. Once again, if the CTO is not informed of these venues for central booking of venues, then they will not be represented in the centrally generated timetable. Communication and sharing of this information between business units is therefore imperative.

Certain venues captured by technical services, being the data owners of the space data, are not indicated on ITS as being lecture venues. Therefore these venues cannot be identified correctly by the extract program causing incomplete data. This also

reduces the capacity for which the timetable can schedule classes. This might prevent a new program from being offered due to perceived insufficient space.

Discrepancies in terminology have also been evident. This is a result of different naming conventions used at the pre-merged institutions. For example, some buildings are referred to by a common name (S-Building, or N1), but do not appear on ITS as Technical Services has used a different code by which to identify the same building. The actual codes on the doors of buildings have also not matched the codes created. This bad data quality has carried through to the timetable as well, at some points making it difficult for students and lecturers to find these venues.

In the case where individual departments have drawn up their own timetables, the situation has arisen where multiple timetables have been available to students. One from their respective departments, one given to the students from ITS at registration, and various ones provided by the different technologies available like the student portal, kiosk system and ITS web system. These timetables may give different views of the timetable data, and possibly different information as well if the technology has been coded incorrectly, or if there was no communication between the CTO and the department.

The complexities highlighted here all have to be taken into consideration when dealing with the quality of the timetable, as each of these issues would detract from the ultimate quality of the timetable.

5.3.3 NMMU Data Quality aspects in Relation to the Business Process

In this section the NMMU timetable business process was linked up to various quality aspects. The way in which this was done was to use the IPMAP technique described earlier (Shankaranarayan et al., 2003) for each of the business processes described above. Figure 5.4 explains the shapes used and what they mean. The IPMAP allows the representation of business unit boundaries, as well as where the data is actually stored and transferred to, and what processes and validation checks are done at which point in the sequence of the information product (IP) generation. Using the IPMAP,

you can see at a glance how many business units are involved, how many information systems are included in the process, and where the individual data elements come from. This is a very high level use of the IPMAP. Much more detail can be stored regarding timing, quality dimensions and actual persons responsible if it is automated (Shankaranarayanan & Cai, 2005).

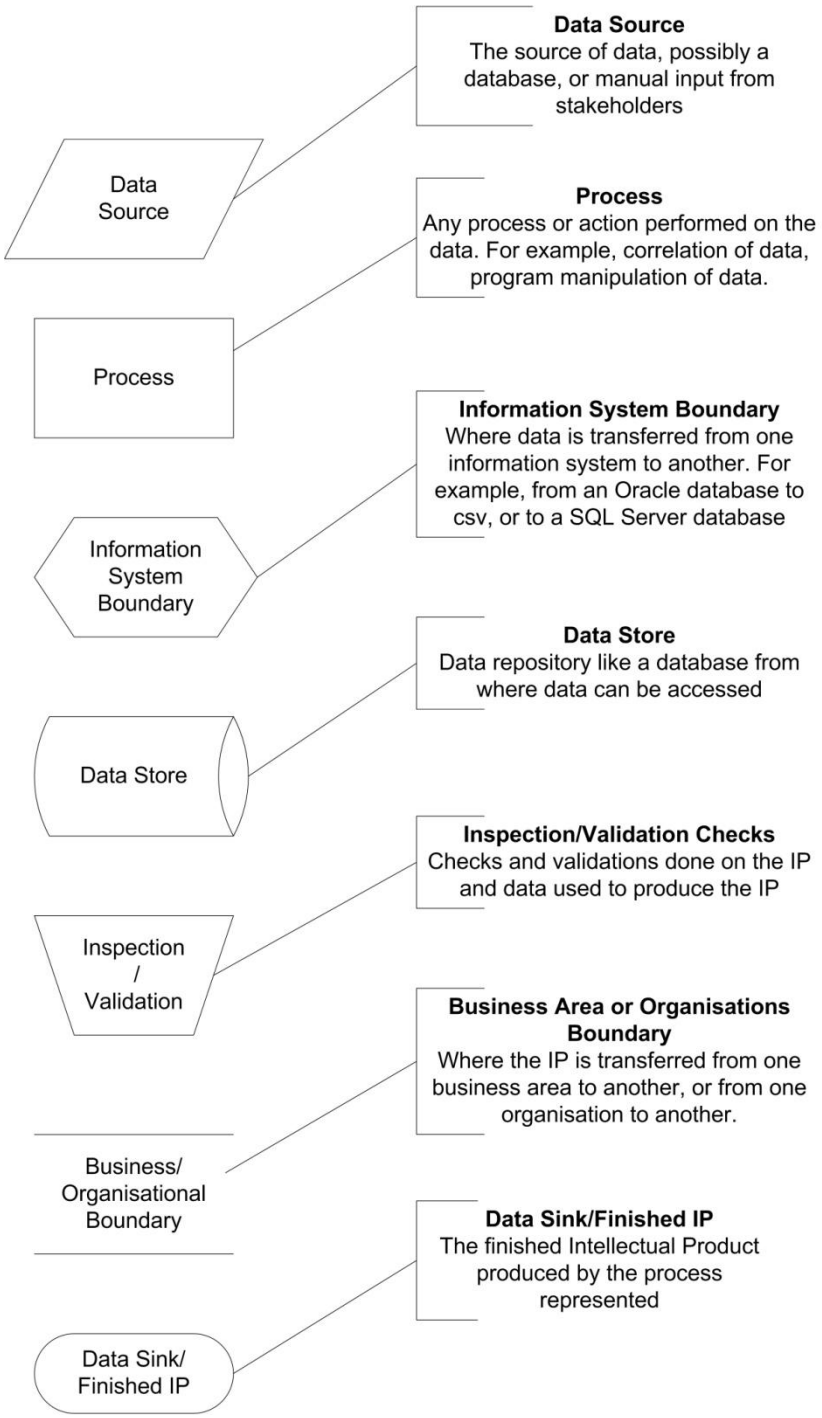

Figure 5.4: IPMAP Shapes and their interpretations.

Figure 5.5 depicts the current process of creating a timetable where the individual departments have attempted to create their own timetables. The CTO is merely related to as a central venue booking system. From the diagram it can be seen that more than one version of the timetable is generated. There are four sources of information, namely Technical Services providing the venue information, Academic Administration providing the curriculum, module, student and session information, HR providing staff and staff leave information, and the Lecturers and their relevant prospectus information. Each of these has different data owners and therefore the quality of these resides with those respective business units, and yet will still impact the timetable data quality.

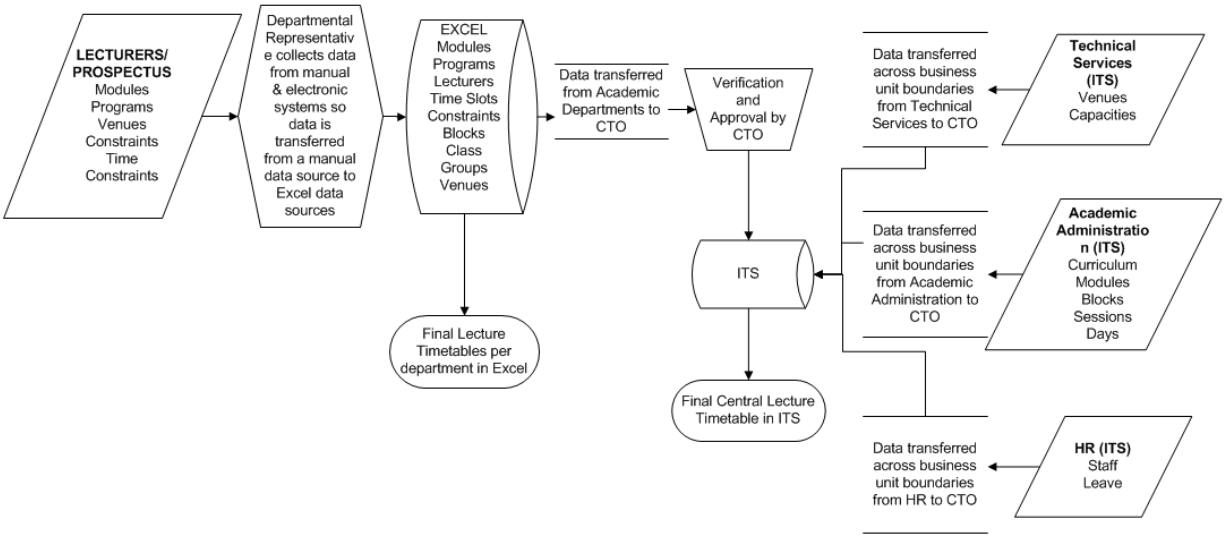

Figure 5.5: IPMAP of Departmental Timetable Business Process.

Figure 5.6 is a representation of the central timetable creation process as it has been proposed to run using O!Time. The data elements are passed across more information system boundaries than Figure 5.5, yet one central timetable is produced at the end.

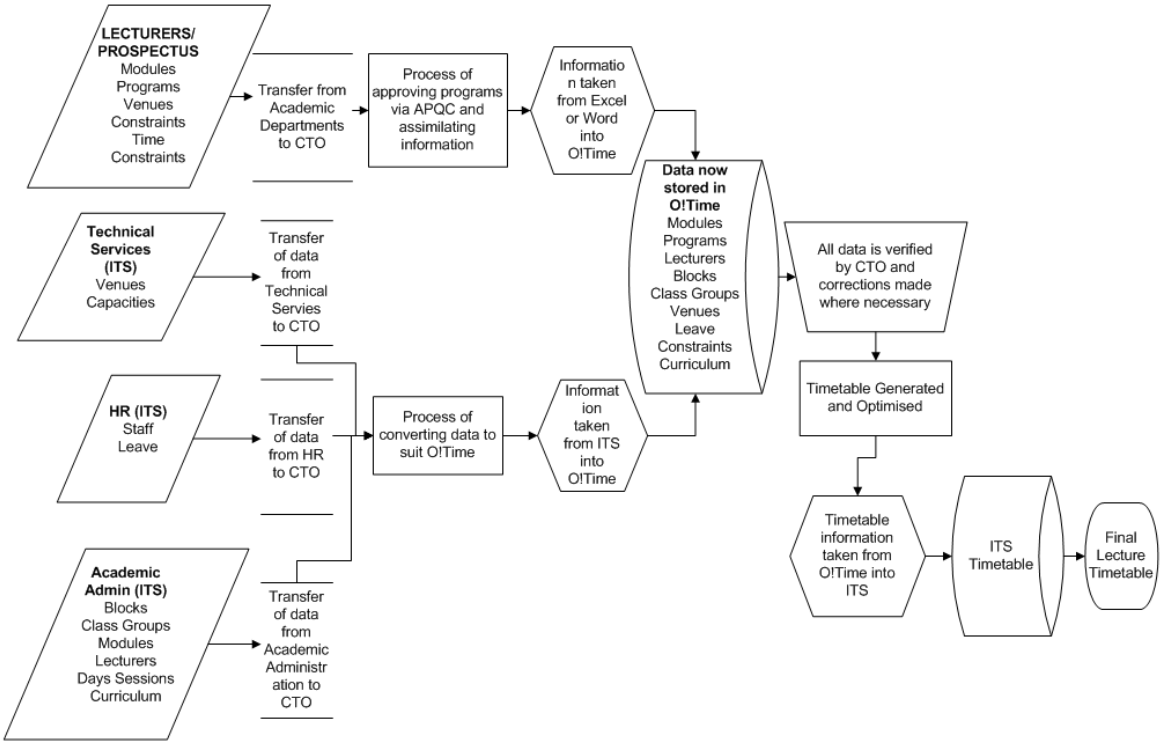

Figure 5.6: IPMAP of Central Timetable Business Process.

Compared to the standard business process in Figure 5.2 and Figure 5.3, here you can see where the information is coming from, and where it is going to. This makes it much easier to apply data quality aspects. Since there are four data sources crossing four business unit boundaries, ownership and accountability will be an important considerations for data quality. You can also tell that there are three places where information is transferred from one information system to another, which would influence the validity of the data, as well as consistency and accuracy. Comparing the departmental IPMAP (Figure 5.5) and the central timetable IPMAP (Figure 5.6), the longest route is 10 steps in the central timetable IPMAP process to get to a final timetable, whereas the longest route in the departmental IPMAP is 7 steps to reach a final timetable. This would have a bearing on the timeliness and flexibility of generating and changing the timetable.

5.3.4 The NMMU Timetable Business Processes

The business processes for the NMMU timetable were determined and drawn up after interviewing the CTO and an academic department. These processes were discussed above.

According to the case study of the NMMU timetable, two business processes seemed to be in existence, using different technologies, and having only the venue booking done centrally at the CTO. These business processes can be viewed in Figure 5.3 for the centralized timetabling business process, and Figure 5.2 for the departmental timetabling processes. The cause for this situation was the merge of three separate educational institutions, resulting in multiple disparate timetables being produced, either by individual departments, or by the CTO.

From the business processes at the NMMU, the complexities in managing a central timetable become apparent. For example, a program cannot be included into the timetable until it has been approved by the APQC, and the APQC cannot approve a program before they know whether there are sufficient venues, time-slots and lecturers available. This becomes an almost impossible task if all the relevant data is not available up-front. This makes using one or a combination of the methods for quality management discussed in Chapter 2 important in managing the timetabling process. Also, as was highlighted in Chapter 3, the data quality characteristics that seemed most pertinent to the timetable included flexibility, completeness, accountability or ownership, and the standard data quality dimensions of accuracy, timeliness and consistency. These would have to be managed in respect to the business process.

The departmental (de-centralized) timetable business process (Figure 5.2) would cater more for quality aspects like flexibility and timeliness, while the centralized timetable business process (Figure 5.3) is more suited to meeting the quality aspects of accuracy, accountability, completeness and consistency, especially over multiple campuses.

Figure 5.5 and Figure 5.6 represent the IPMAP of the two NMMU business processes encountered. The ownership for each data source, the various business units involved in the process, and the sequence or flow of data though various processes and technologies before producing the final information product in the form of the timetable can be clearly seen. The findings of the IPMAP business processes for the NMMU timetabling process indicate that accountability/ownership across all business units, as well as completeness and consistency in the quality of the data between the various technologies is important for the process to work correctly. This is in line with the conclusion drawn from the literature study on business process best practices in Chapter 2. In order to implement continuous improvement in a process, certain relevant quality aspects would need to be measured. It would therefore be best to measure the quality aspects identified as being most relevant to the NMMU timetable.

5.4 Top Data Quality Aspects Identified for the NMMU

In order to determine the most appropriate method for managing the data quality of the NMMU timetable, literature studies were done on business processes and best practices pertaining to total quality management, as well as a literature study on data quality dimensions. The current scenario at the NMMU was determined based on interviews and presented in this case study.

As efficient data quality management must include informing and providing the user of the system with a way of determining its data quality as deemed relevant to them, a systematic approach needs to be determined for managing its data quality (Shankaranarayanan & Cai, 2005; Shankaranarayan et al., 2003). Therefore the most relevant data quality aspects to the NMMU and the perceived causes of bad timetable quality have been determined using a questionnaire.

The data quality aspects most relevant to the NMMU were analyzed according to the questionnaire set out in Appendix A. There were 21 responses to the questionnaire from North, South and 2nd Avenue campuses. The results of this questionnaire is delivered as follows: Academic versus Administrative Timetable Quality Aspects,

North Campus, 2nd Avenue Campus and South Campus Timetable Quality Aspects, and the Overall Timetable Quality aspects.

According to Figure 5.7 and Table 5.1, both academic and administrative staff are in agreement with the top three data quality aspects that are most relevant to the NMMU, these being accountability, timeliness and integrity. They differ in the remaining seven quality aspects though, with academics wanting consistency and ease of use, versus administrative staff needing accuracy and completeness. Considering that academic and administrative staff have different functions relating to the set-up and use of the timetable, these differences are understandable. Academics use the finalized timetable so want it to be on time and easy to use, while administrative staff that set up the timetable needs the source data to be complete and accurate.

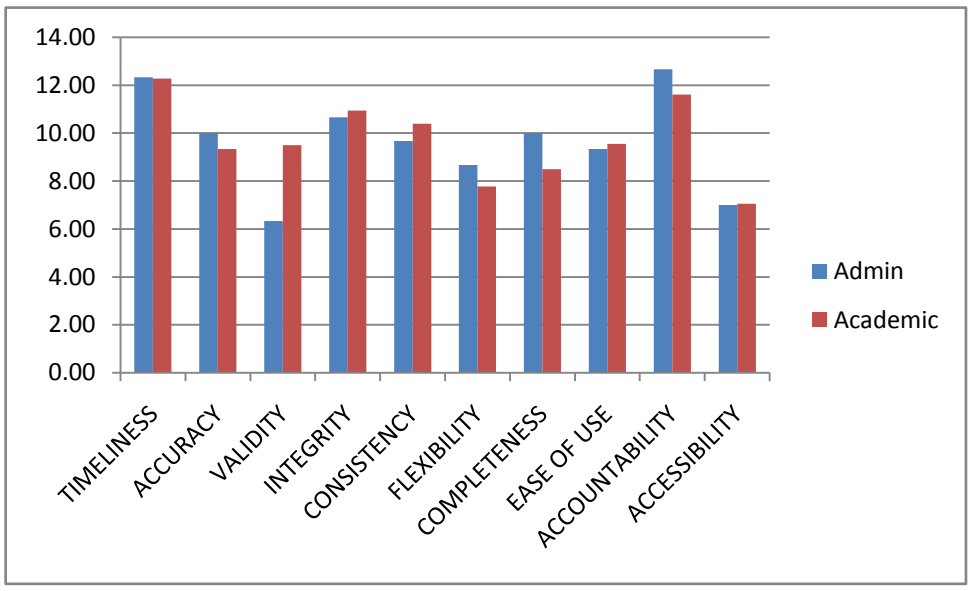

Figure 5.7: Perceived impact of data quality aspects on the NMMU timetable for Academics and Administrative staff.

	NMMU	Admin	Academic
TIMELINESS	12.29	12.33	12.28
ACCURACY	9.43	10.00	9.33
VALIDITY	9.05	6.33	9.50
INTEGRITY	10.90	10.67	10.94
CONSISTENCY	10.29	9.67	10.39
FLEXIBILITY	7.90	8.67	7.78
COMPLETENESS	8.71	10.00	8.50
EASE OF USE	9.52	9.33	9.56
ACCOUNTABILITY	11.76	12.67	11.61
ACCESSIBILITY	7.05	7.00	7.06

Table 5.1: Percentages for data quality aspects most pertinent to the NMMU for Academic and Administrative staff.

Figure 5.8 and Table 5.2 represent the data quality aspects most pertinent per campus. Three campuses responded, 2nd Avenue, North and South campus, therefore the quality aspects of George and Missionvale could not be established. For the largest two campuses (North and South campus), timeliness, accountability and integrity were at the top of the list, while 2nd Avenue campus looked for consistency first, and then timeliness and accountability. Therefore all campuses are looking for timetables that can be delivered on time, and there seems to be a great need for the accountability of the timetable to be clarified.

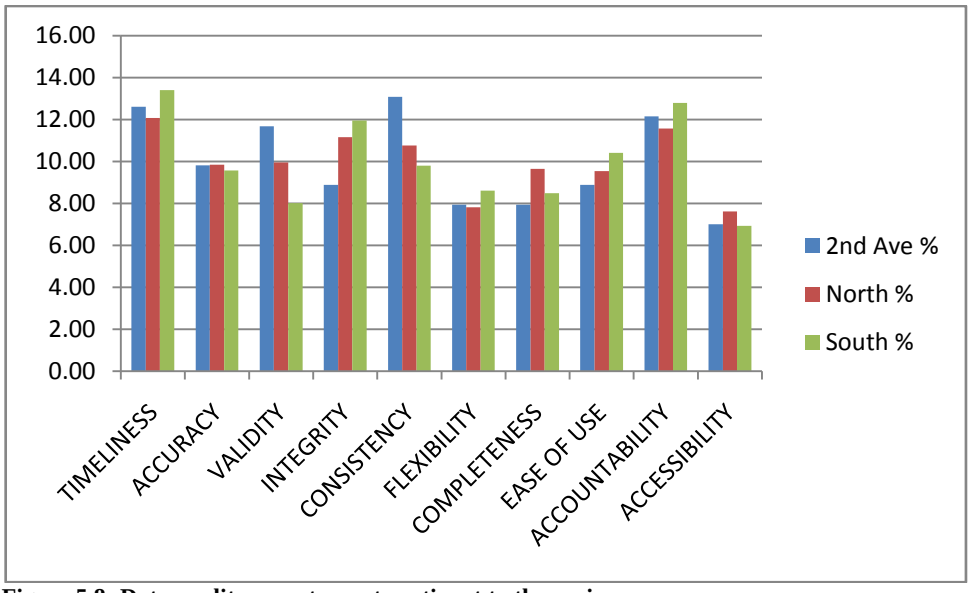

Figure 5.8: Data quality aspects most pertinent to the various campuses.

Quality Aspects	2nd Ave %	North %	South %
TIMELINESS	12.62	12.08	13.40
ACCURACY	9.81	9.85	9.57
VALIDITY	11.68	9.95	8.01
INTEGRITY	8.88	11.17	11.96
CONSISTENCY	13.08	10.76	9.81
FLEXIBILITY	7.94	7.82	8.61
COMPLETENESS	7.94	9.64	8.49
EASE OF USE	8.88	9.54	10.41
ACCOUNTABILITY	12.15	11.57	12.80
ACCESSIBILITY	7.01	7.61	6.94

Table 5.2: Percentages for data quality aspects most pertinent to the various campuses at the NMMU.

The overall data quality aspects for the NMMU are represented in Figure 5.9 and Table 5.1. As already noted above between campuses and between academic and administrative staff, timeliness, accountability, integrity and consistency have the highest percentage relevance. It is interesting to note that accessibility and flexibility were the lowest on the chart, even though flexibility was highlighted as a required quality dimension for timetables in Chapter 3. Accountability and timeliness are important quality aspects as expected from the literature study, and integrity often includes qualities like completeness, consistency and accuracy. Lack of data integrity indicates a lack of trust in the timetable data and processes. These quality aspects identified as the most relevant to the NMMU timetable would make the best measures for it.

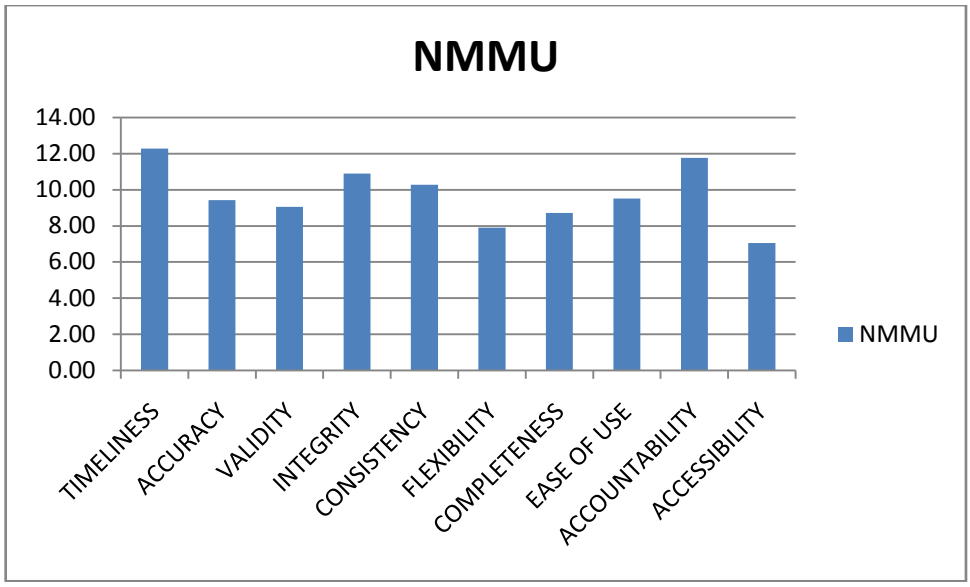

Figure 5.9: Percentages for overall data quality aspects for the NMMU Timetable.

5.5 State of the Current Timetable Data Quality at the NMMU

The current state of the timetable data at the NMMU was determined using the questionnaire in Appendix A, Section 3. The answers can be viewed in Appendix B. The perceived causes for bad timetable quality are split under the extrinsic data quality aspects resulting from the output of the information systems as identified from Chapter 3.

5.5.1 Data Interpretation

Data interpretation relates to questions 3.1, 3.2 and 3.3 in Appendix A and B (Table 5.3).

3.1	What is the main purpose that you use the lecture timetable for?	*Scheduling lecture times, venues and staff *Space usage *Statistical reporting
3.2	Does the timetable give you all the information that you are looking for?	*Yes *No If No, what has been left out…?
3.3	What problem has the timetable solved, or not solved, for you?	

Table 5.3: Data Interpretation Questions

As stated above, academic staff and administrative staff have different goals in mind when it comes to the timetable. Therefore the data is interpreted in different ways, not only by academic and admin staff, but also possibly between campuses, programs and delivery modes. Data interpretation asks the question: What problem has the information solved for you? And has it conformance to specification?

To be able to interpret data accurately, you need to understand the purpose for which it is required. Table 5.4 shows that the majority of respondents to the questionnaire use the timetable to schedule lecture times, venues and staff. The second purpose is for statistical reporting, then for venue or space usage, and 7.69% of the respondents use their own internal timetable.

The main purposes that the lecture timetable is used for.	**%**
Scheduling lecture times, venues and staff	65.38
Space usage	11.54
Statistical reporting	15.38
I never use the its timetable, as we have dedicated venues with our own internal timetable	7.69

Table 5.4: Purposes of the Lecture Timetable.

Considering the fact that the majority of respondents use the timetable for scheduling, 76% responded that the timetable provided all the information they were looking for, while 24% said it did not. From the responses, four generic reasons as to why the timetable data was not necessarily interpreted correctly by the remaining 24% could be determined. These included the lack of data, like no fixed furniture information, no venue sizes indicated, facilities like data projectors were not indicated on the timetable venues, and whether the class was a practical, tutorial or lecture was not there. The lack of training on where to find and use the timetable was another reason that the timetable was not interpreted correctly. A lack of knowledge of the timetabling process was another area for misinterpreting the timetable, and lastly was incorrect data. For example, module names differed in the timetable to what the lecturers are use to, class types and class groupings were wrong, and the actual space or venue numbers did not correspond to the timetable.

Academics and administrative staff also interpret the timetable differently. Administrative staff need all the timetable data to be captured into ITS in order to create a complete centralized timetable across all campuses. For example, if no dedicated venue information is available on ITS, then the timetable will not contain this information leading to a misinterpretation of the timetable in that it is assumed that all modules must be scheduled only to the venues available in ITS. Academics on different campuses also interpret the timetable differently, so much so that 2nd avenue campus responders have solved their own timetable problems by finding alternative venues to suit themselves. The timetable has not solved certain requirements like large class groups on specific campuses, consecutive time-slots necessary for in-service modules, flexible class sizes, and the timetable having no consistency from year to year, causing it to have to be re-interpreted each year. All these factors are indicative of timetable data that is not being interpreted correctly for various reasons.

5.5.2 Ownership

Ownership relates to questions 3.4, 3.5, and 3.6 in Appendix A and B (Table 5.5).

3.4	What section of the timetable are you responsible for?	*Maintaining Venues *Maintaining the academic structure *Giving feedback to Academic Admin when modules or delivery modes change, to Technical Services when new venues or their attributes change, or to the Timetable office regarding dedicated venues and your lecturing requirements *Maintaining and generating the main timetable *Maintaining an individual timetable for a specific campus * Other section…
3.5	How do you communicate with other departments regarding the setup of your timetable and resolving clashes?	
3.6	What problems will a central timetable cause for you?	

Table 5.5: Ownership Questions

By various departments owning different sections of data required by the timetable, it means that data quality can vary between sections, and ultimately have an impact on the final timetable produced. This is not only relevant to data sources, but also to who

is responsible for which process involved with the creation of the timetable. Administrative staff are mainly responsible for maintaining and generating the main timetable, maintaining the venues and reporting. The data owners are clearly specified in the IPMAP business processes in Figure 5.5 and Figure 5.6.

At the NMMU, many academic departments are also responsible for maintaining their own departmental timetables, creating the scenario where more than one business unit is responsible for the same function. In most instances, academic departments will not be maintaining the actual venues, but simply book the venues with the CTO, unless they are responsible for their own dedicated venues. Unfortunately this leads to incomplete data and incorrect reporting on the central ITS timetable. Many of the academic departments report curriculum changes to academic administration and the CTO, as well as reporting venue changes to the relevant business area. It is clear that there is no consistency in the ownership of the timetabling processes.

Communication is a large part of sharing responsibilities and ownership. From the responses on communicating clashes in the timetable, communication methods varied from email and telephone, to meetings with the CTO. For those departments setting up their own timetables, other departments need to be consulted as well as internal staff. This would be one of the problems that a centrally generated timetable, using a central standard business process would solve.

If ownership was transferred to central ownership (question 3.6), other problems were expected like lack of timeliness, less flexibility for lecturers, and a concern that there would not be enough staff at the CTO to deal with all the queries and timetable changes. Not all respondents were averse to a centrally owned timetable, but thought it could actually solve their timetable problems.

There was the largest number of relevant responses to the questions pertaining to ownership, which could indicate that it is a contentious and relevant issue affecting the quality of the timetable. Ultimately, a clear accountability for the timetable and the underlying data is essential for a quality timetable.

5.5.3 Uniform Technology

Uniform technology refers to questions 3.7, 3.8 and 3.9 in Appendix A and B (Table 5.6).

3.7	If you are setting up a timetable, or providing information to the Central Timetabling Office, where do you get most of your information from?	* ITS * Celcat * Excel * O!Time * Other (Please specify…)
3.8	Do you have to do a data clean-up before you can use the data? (I.e. convert it into another format)? Please explain...	
3.9	Do you have to capture the timetable more than once? (For example, in your own system, like excel, as well as into ITS, O!Time or other system). Please specify where you do capture it…	

Table 5.6: Uniform Technology Questions

Does all the data come from the same database, or is it manipulated along the way by other programs, systems or manually? The more interfaces the data has to go through before reaching the end result, causes there to be more margin for error, thereby reducing the quality of the data.

Currently data is accessed from numerous data sources by anyone setting up a timetable at the NMMU. These sources include ITS where the main academic structure is stored, old timetables stored in Excel, Celcat, the old PET timetabling system, O!Time, reports on the NMMU staff portal, and various other places. Table 5.7 shows that ITS, Excel and other data sources are the most often used from which to source timetable information.

Technology	%
ITS	32
Celcat	4
Excel	16
O!Time	4
Staff Portal/Intranet	8
Other	36

Table 5.7: Sources of timetabling Information.

Other sources of information for setting up departmental timetables include the APQC document, consulting with other departments, internal programmes, past timetables already set up to meet their unique course structure, past experience, and by consulting lecturers or own departmental staff. Without this, many of the constraints to the timetable would not be identified.

Often, if data comes from many data sources, the data needs to be cleaned or manipulated before it can be used. From the results, 80% do not need to clean-up data as it is not necessarily relevant to them as they source their information verbally and not from databases, and 20% are involved in cleaning data which seemed to focus on North campus venue data in ITS.

On the other end of the process, data quality is determined by the output of the information provided. Discrepancies can exist if many modes of delivery are available using different technologies to provide the final timetable. This seems to involve the re-capture of the timetable, mostly into Excel, Word or O!Time.

5.5.4 Uniform Procedures

Uniform procedures looks at questions 3.10, 3.11, 3.12, 3.13, 3.14 and 3.15 in Appendix A and B (Table 5.8).

3.10	What process do you follow to get a timetable – briefly?	
3.11	Can students access their own timetables in your department?	
3.12	How many different places can you access the lecture timetable in order to query or print it?	* Staff Portal # * Student Portal # * Kiosk# * ITS # * Excel # * MIS# * BI# * O!Time * Other #
3.13	Do you experience clashes between various timetables, and how do you recommend going about resolving them?	
3.14	Are you aware of any specific policies impacting on the lecture timetable?	If yes, please specify which policies….?
3.15	Are you aware of anything that would have an impact on the lecture timetable (For example, NQF credit changes…)?	

Table 5.8: Uniform Procedures Questions

Does everyone follow the same process for capturing data, or is there more than one way to do the job? On the other end of the process, is there one point of access, or is the same information delivered in various places, possibly for different purposes, opening gaps for erroneous interpretation of the data?

The processes followed at the various campuses are described briefly in the next few paragraphs.

2nd Avenue Campus followed its own processes which did not include the CTO. They would work through every subject in every program to check for clashes for the programs they offered, as well as meeting with the timetable coordinators from various departments.

North campus staff said they used ITS to extract information, and also old timetables that they knew worked. They would manually change lecturers if needed, but most would book venues with the CTO. Most of the North campus timetables seemed to be captured in Excel and then emailed or handed out to students.

South campus respondents used the centrally generated timetable sourced from ITS which was also directly displayed on the staff and student portals. The risk of clashes between campuses based on the processes described above is therefore great.

Since each campus follows their own process of compiling their own timetables, the mechanisms provided to students to access their timetables would have to differ as well. 85% of all respondents said their students could access their own timetables, and 15% said no. The mechanisms provided for students to access their timetables were not only restricted to the CTO generated timetable given to students at registration, but also included departmental notice boards, email and on the course websites as set up by the department themselves.

This brings us to the question of how many access points are there for students and staff to access a timetable, irrespective of whether it is consistent or not. Table 5.9 gives an indication of the various places a timetable can be accessed from. The

majority of respondents accessed the timetable from the staff portal, which is directly sourced from the central timetable generated on ITS, as is the student portal, Kiosk, ITS and O!Time. Timetables provided in Excel (8.82%), from the MIS system (5.88%) and other sources (11.76%) do not come directly from the central ITS timetable, but have been generated elsewhere first before notifying the CTO to update ITS. Many times ITS is not kept up to date with these other timetable sources. Hence 73.53% access the central timetable and 26.46% their own departmental timetables on their departmental SharePoint sites, or from their departmental secretary.

Timetable Sources	%
Staff Portal	41.18
Student Portal	8.82
Kiosk	2.94
ITS	5.88
Excel	8.82
MIS	5.88
BI	0.00
O!Time	14.71
Other	11.76

Table 5.9: Timetable Access Points.

Once again, the risk of each point of access providing different information that may clash with a timetable accesses somewhere else is great. The response to the question as to whether timetable and venue clashes occurred, 62% said that they did experience venue clashes due to the various timetables, while only 38% do not. If the processes differ, then the end result will more than likely differ as well.

These clashes were resolved manually by contacting the clashing department to discuss the issues and make changes, or use other venues within the department which is not always suited to the number of students or class type. A few would contact the CTO to assist. From the responses it was clear that feelings ran high regarding venue clashes and clearly indicates the need for uniform procedures and one central timetabling process.

Only 33% of staff was aware of the existence of NMMU timetable policies, but not necessarily the content or which ones they are. 67% do not know that NMMU policies governing the timetable processes and content exist.

Staff seems to be aware that the number of lecturers, subjects, classes per staff member, class and venue sizes as well as the credit values assigned per program will impact on the structure of the timetable, but no-one mentioned the process that would need to be followed to coordinate any of these changes.

Putting uniform procedures in place and communicating them to staff are therefore very necessary for the NMMU timetable process.

5.5.5 Common Terminology

Common Terminology looks at questions 3.16, 3.17, 3.18 and 3.19 in Appendix A and B (Table 5.10).

3.16	What do you call the lecture timetable in your department?	
3.17	Are there venues that you refer to by a different name to what appears on the door, in ITS, or on the Timetable? If yes, please give an example…	
3.18	Do you have another name for :	* Class groups (A) * Group Types (Tutorial, Practical, Class) * Offering Types (01, A1) * Block codes * Any combination of these…
3.19	Do you use the module/subject codes, the module brief description, full description, or your own description?	

Table 5.10: Common Terminology Questions

Having a common terminology means that the same naming convention is used in all places that certain information is available so that everyone who uses it will interpret it with the same understanding. For example, is it possible for headings to be misleading about the content of the information? Are a uniform set of definitions or formulas being used for the timetable?

Form the questionnaire, most of the departments used the same terminology for the lecture timetable. The only differences were for departmental timetables that had been

set up for specific purposes. Unless a departmental timetable set up apart from the central timetable has a different name, it is difficult to tell whether the source of information came from the CTO or elsewhere.

Timetable venue names differed from the venue names used by the lecturers in some cases, or from the signage on the physical lecture venues for some campuses causing confusion for the students. For example, the Technical Services department had re-numbered all venues on the ITS system without replacing the signage on the venue doors in all cases. Venues on the lower ground that were previously referred to as lower ground, were now referred to as "-1". From the answers given in the questionnaire (Appendix B, question 3.17), no common terminology existed for venues when the timetable was created.

The terminology in use for class groups, class types, offering types and block codes was also investigated. Class groups are used for grouping sub-sets of students per subject on the timetable so that whole classes can be split between venues or time-slots. Most departments did not use class groups, except for the Chemistry department who set up their own timetables and different codes than those in ITS to identify groups of students. Class types on ITS include classes, tutorials and practical. Another terminology for class is "lecture", and the Nursing Science department used an extra class type of "remedial". Otherwise class type terminology was standardised across all departments who responded. On ITS "offering types" indicate the delivery mode of subjects. These are defined as full time or part time per campus. Some respondents did not know what "offering type" referred to and interpreted it as "teaching venues" or "modules", while one department simplified the offering type into "full time" and "part time" only. Therefore the terminology of "offering type" is not commonly known. "Block codes" used in ITS refer to teaching blocks like Semester 1 and 2, Term 1,2,3 and 4, or Summer and Winter school. While most departments knew the term, not all were familiar with it.

Another possible disparity in terminology is subject code and description. However, it was found that all respondents used the subject code and either full or brief description as on ITS.

The NMMU timetable therefore has a fairly common terminology in place for the main components of the timetable across the various business areas involved in setting up and using the timetable except for venue names which originates from the Technical Services department. Figure 5.5 illustrates the cause of this problem where Technical services updates ITS as its primary data source without any input into the departmental timetables. The only common point of reference between technical services and the academic departments is the CTO.

5.6 Shortcomings of the NMMU Timetable Process

Chapter 2 discussed various business processes and quality control frameworks for management. Chapter 3 highlighted the data quality aspects that seemed to be most relevant to producing a quality timetable, bearing in mind that quality is ultimately defined as whether it is satisfactory for the purpose for which it was intended.

The purpose of the lecture timetable at the NMMU is to schedule classes in a timely manner so that all programs offered fit into the space and time-slots available. The number of lecturers and venue capacities are constraints to the generation of the timetable. From the first and second sections of the questionnaire, it was determined that timeliness, accountability, integrity and consistency were the most relevant data quality aspects for the NMMU timetable. The extrinsic factors affecting the quality of the timetable from the third section of the questionnaire highlighted that uniform procedures, uniform terminology and ownership of the timetabling process and component data sources were the major causes of bad data quality in the timetable. Using uniform technology and data interpretation did not seem to impact on the timetable to the same extent.

The shortcomings of the NMMU timetable are lack of a well communicated timetabling process resulting in multiple disparate timetables between departments and technologies, lack of data ownership by the responsible business areas to ensure the quality of their respective data as well as no accountability when not communicating all the necessary information to the CTO, and problems with venue terminology. These issues impact on the quality aspects identified by slowing down

the timetable generation process, reducing the integrity of the information used and causing a lack of consistency as timetable information is available in many different forms, often conflicting with one another.

Relating this to the timetable business processes in Figure 5.2 the current situation is evident. The current situation described above can be prevented by using the standardized central timetabling process in Figure 5.3 which would increase consistency, accountability and data integrity. However the timeliness of the timetable would still be of concern.

In order to formalize a uniform process across all departments, including an approach of continuous improvement to increase the quality of the timetabling process, a standardized approach would be necessary. From Chapter 2, the main components needed for the management and control of quality processes were:

- top management involvement
- roles, responsibilities and ownership
- impact of processes upstream and downstream of process in question
- communication - training and documentation of processes
- continuous improvement
- performance measures
- information technology as an enabler only, rather using people's expertise as the driving factor.

Relating this to the NMMU timetabling process as set up by Erasmus (2008) and represented in Figure 5.3 and Figure 5.6:

- Top management involvement is essential for the timetabling process to work as it involves the coordination of many business areas and separate academic departments. As pointed out in ISO 9001 (2000), communicating the importance and reason for implementing a quality process must come from top management. They are also responsible for ensuring that the required resources are available.
- The roles, responsibilities and ownership for facilities management have already been highlighted for the NMMU by Erasmus (2008). The CTO is

stipulated as being the central point of contact for all facilities information, and Technical Services are presented as the data owners of the space information which must be captured and maintained in ITS. What was not highlighted was the cross-functional area transfer of data and where the responsibility for this lies. The IPMAP diagram for the NMMU Timetable data in Figure 5.6 displays the points where data is transferred from one business area to another. These include transferring data or information from academic lecturers, technical services, human resources and academic administration to the CTO. Although the various sub-sections own the data, once it has been amalgamated into the CTO timetable, the new information derived becomes the responsibility of the CTO. It may therefore be considered CTO's responsibility to ensure that the other sections provide and maintain quality data in a centrally accessible location.

- Based on the point made above, the impact of processes upstream and downstream of the timetabling process must therefore be assessed. If Technical Services or Academic lecturers provide incorrect data, it will impact on the timetabling process. And if the timetable is inaccurate it impacts on the processes of the academic departments implementing the curriculum. Therefore the impact on the processes both upstream and downstream of the timetabling process must be monitored.
- Communication can be considered as the "glue" that ties the various business area processes together. Erasmus (2008) has already provided policies and procedures pertaining to facilities management at the NMMU. This documentation forms the benchmark for the timetabling process. These policies need to be communicated via top management, and training on the procedures is necessary so that all relevant business areas follow the same approach, thereby improving the consistency of the process as well as the timetable produced.
- Erasmus (2008) includes the continuous monitoring and evaluation of the policies in place so that the process can be improved upon. Once again top management involvement with the process of evaluation is necessary to ensure that it stays aligned to the NMMU's objectives, and so that any changes to the process can be communicated.

- The one aspect of quality control that is lacking for the NMMU timetable is the presence of performance measures. This ties in with the data quality aspects that were identified as being the most relevant to the NMMU timetable process: timeliness, accountability, integrity, consistency (including common terminology, uniform procedures, and uniform technology), and ownership. Continuous improvement cannot be implemented without them. Therefore it is proposed that these quality aspects be used as measures for the NMMU timetable quality control process.
- Lastly, the information technology used at the NMMU must be used as an enabler only. ITS should form the central source of information. O!Time was purchased to enable a faster and more optimized generation for the timetable, but from the questionnaire it looks as though it has reduced flexibility as this technology cannot easily cater for soft constraints based on individual department and lecturer's requirements. If O!Time meets the quality requirements for the NMMU (timeliness, accountability, consistency and data integrity), then it can be considered an enabler for the NMMU Timetable. This may be considered the case as flexibility and accessibility, which O!Time lacks, were not high on the list of quality aspects. People's expertise must still be the driving factor for the timetable. To facilitate this, good feedback mechanisms must be in place.

The NMMU timetable process therefore still requires an assessment of the impact of processes upstream and downstream of it, a well defined communication procedure, continuous improvement measures, and feedback mechanisms so that people's expertise can be incorporated into the process.

5.7 Conclusion

As discussed in the introduction, having a quality timetable is one of the key factors to reaching the objectives of the NMMU. A low quality timetable will impact on student perception of the university. Therefore managing the NMMU timetable quality is necessary. This cannot be done without considering the business processes in place for creating the timetable. Unfortunately, due to pre-merger differences in creating the timetable, there are still a lot of discrepancies in the current process.

It was also shown that various business units are responsible for the underlying data used to create the timetable, so the quality of these data sources will influence the quality of the final timetable. It also supports the fact that top management involvement is crucial to the quality management of the timetable process.

The IPMAP technique was utilized to indicate data flow to create an information product, in this case the timetable. By using this technique, it was easier to understand the implications of data quality at various stages of the process. Certain assumptions have been made in that manually entered data available from another source comprises on accuracy, data stored in more than one place reduces consistency and is more prone to error, and different data owners often use different terminology and do not understand the impact their data has on related systems. Therefore communication is critical to the success of creating a quality timetable. As yet, there is no quality management framework in place, although the timetable process is managed and is part of NMMU policy.

The most relevant data quality aspects for the NMMU were identified. The reason for this is that quality is defined as whether it meets the quality requirements for which it was specified. These were timeliness, integrity, accountability and consistency. The extrinsic quality aspects that caused bad quality within the timetable were the lack of ownership of data and processes, non-uniform procedures between academic and administrative departments, and the lack of a common terminology in use.

This chapter has shown that in order to create a quality timetable for the NMMU, the data quality will have to be managed throughout the process and across all business areas involved. Ownership, accountability and management involvement are essential.

Chapter 6: Conclusion and Recommendations

6.1 Background and Description of Study Area

Timetables form part of the core operations of any scholastic or tertiary educational environment. It ensures the smooth day to day running and coordination of the many aspects involved in a tertiary environment. These usually include the curriculum, lecturers, venues, time-slots and students, and need to cater for constraints like venue capacities, lecturer availability, restricted times and program changes.

It is part of the NMMU's objectives to provide a supportive environment that attracts and keeps students, as well as to cater for a large number of academic programs. Quality management and continuous improvement also form part of the NMMU's objectives (Nelson Mandela Metropolitan University, 2008). Therefore a core process like the timetable needs to be able to support these objectives by working to quality standards within the constraints surrounding it.

As described in Chapter 1 and in the Case Study in Chapter 5, due to the merge of three tertiary institutions, the NMMU was in the situation of having inconsistent data of low quality. This severely impacted the generation of a coherent timetable even with additional technology specifically purchased for this purpose. This in turn reflected negatively on the business objectives of the NMMU.

The goal of this research was to find a way in which to manage the data quality issues within a business process, as the ultimate quality and reliability of the process is dependent on the quality of the source of the required data. The NMMU timetable was used as a case study to investigate the best possible solution.

6.2 Problem to be Solved

The lack of quality data within an organization can hinder its performance and cause customer dissatisfaction (DM Review, 2007; Henderson, 2005). This reflects the situation within the NMMU timetable.

In order to solve the problem, four research questions were proposed. Firstly, what was the current business processes used to produce a timetable for the NMMU? Secondly, what data quality aspects were most relevant to the NMMU timetable users? Thirdly, what the data and technological characteristics were that caused bad quality within the timetable, and fourthly, what the data quality aspects were related to the timetable business process.

Literature studies were conducted with the focus on data quality characteristics, and business process and quality best practices, and these were applied to the NMMU timetabling process.

6.3 Solution & Recommendations

A framework for managing data quality in relation to the timetable, including metrics for continuous improvement and using a systematic approach for managing data quality taken from proven TQM methodologies is therefore proposed. Quality must be ensured at the source and capabilities to trace data quality issues need to be included according to Shankaranarayan et al. (2003).

From the quality aspects identified as being the most relevant to the NMMU timetable process, as well as the literature study done in Chapter 2 on quality control process best practices, the most appropriate way to manage the quality of the timetable is proposed. This includes a way in which to inform the stakeholders at each point in the process what the quality, in terms of timeliness, accountability, integrity and consistency are so that corrective measures can be taken in a timely fashion. The best practices highlighted in the Quality Control Cycle (Karacsony & Terry, 2007), IPMAP framework (Shankaranarayanan & Cai, 2005; Shankaranarayan et al., 2003), and ISO 9001 (ISO 9001, 2000) were included in the proposed framework for managing the NMMU timetable quality. These included top management involvement and communication, well defined roles and responsibilities, training and process documentation, assessing the impact of related processes upstream and downstream, continuous improvement, using information technology as an enabler, getting feedback from people's expertise and evaluating the end result of the process. These

were related to the NMMU business processes for the timetable in the form of an IPMAP, including the quality aspects identified for the NMMU timetable used as continuous improvement measures.

A framework for managing the timetable process at the NMMU would include an IPMAP of the way the process should ultimately work (i.e. shortest route, ownerships, fewer data sources and only one end IP). This would continually be managed to evaluate problematic areas by using performance measures at each relevant point in the IPMAP for continual improvement as depicted in Figure 6.1. The improvements would have to be implemented and communicated via a standardized training and documentation process.

Measures for timeliness could include the duration from the onset of the process, to the various milestones in the process so that a comparison can be made with the next time the timetable is produced.

Accountability can be specified within the IPMAP per data source as actual names so that the person accountable for the provision or capture of the data is known at all times.

Data integrity can be measured as 1-(Number of data items in error/total number of data items) within the database (Shankaranarayan et al., 2003). For this to work a common terminology or set of definitions must be used across all departments. This can be measured at each milestone within the IPMAP and compared to the previous measure. For example, are all venues referred to by the same name in all the data sources represented? Or a count can be done of the number of seats per venue in all sources in relation to the number of students per subject group.

Consistency includes using a common terminology, uniform procedures, and uniform technology. It can therefore possibly be measured as the number of reports available from where the timetable can be viewed, and whether each of these have the same measure of integrity as defined above. Uniform procedures and technologies can be measured as the count of different sources of timetable. For example, the number of

different Excel, Word or other timetables available between departments versus the timetable produced from ITS and O!Time.

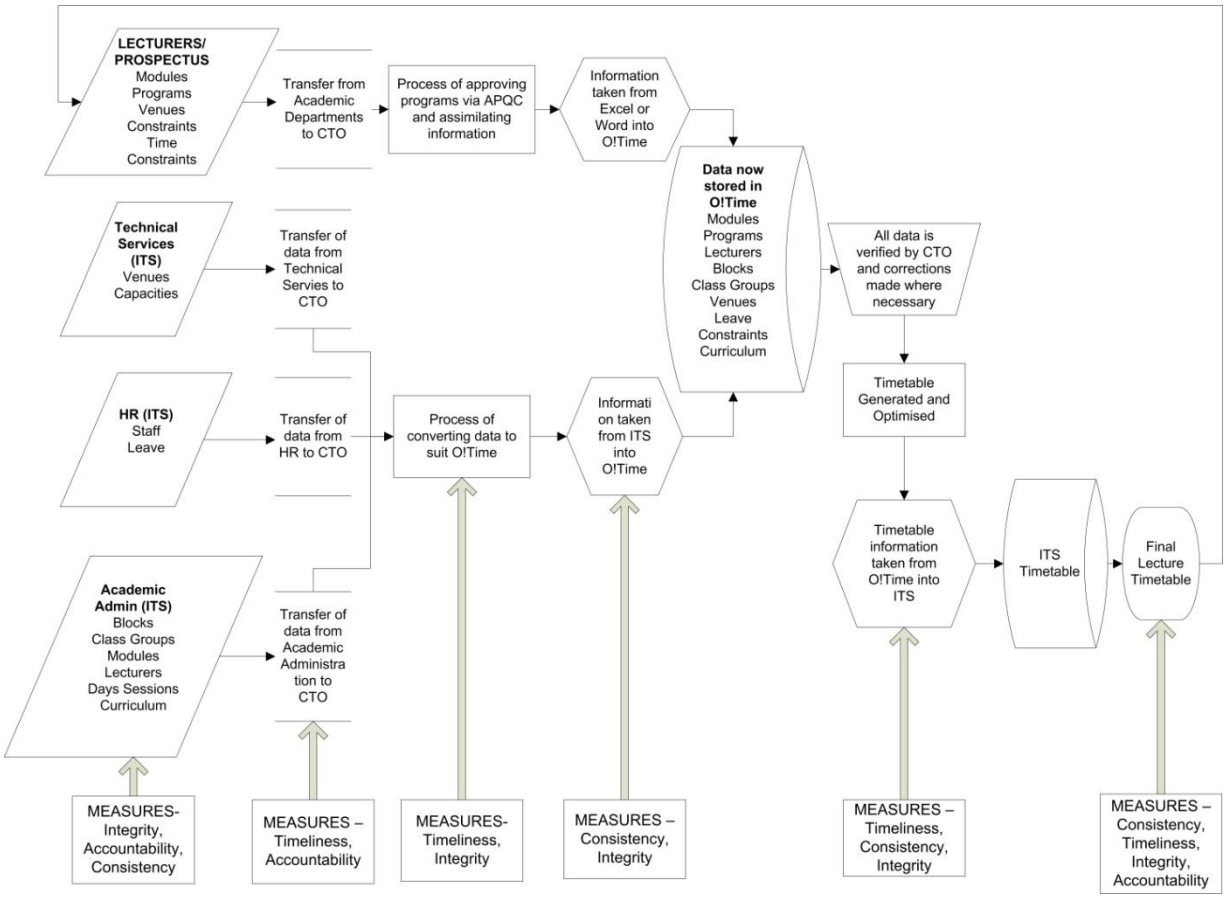

Figure 6.1: Proposed Measures for IPMAP of NMMU timetable quality process.

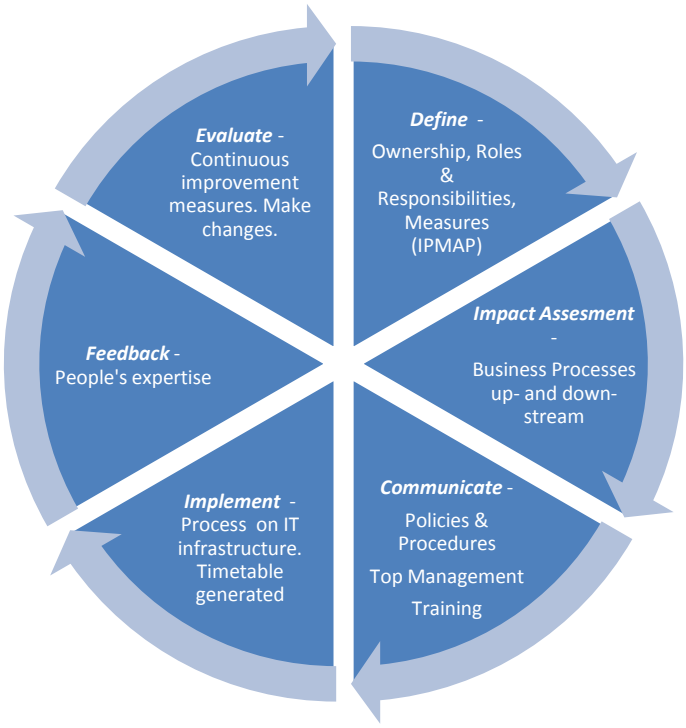

Figure 6.2: Proposed Framework for a quality timetable process.

Figure 6.2 shows the proposed framework for managing a quality timetable.

The "Define" stage would include setting up or adjusting the current IPMAP of the NMMU, or any other, timetable process. This includes the owners of the data and the measures to be used. Once this has been done, an impact assessment needs to be done to determine whether the impact of the proposed process would negatively affect relating processes. An example of this would be the impact on the APQC process as they would need the information from the timetable to be in place, before approving new curricula. This is not always possible within the timeframes available. Downstream of the timetable, the quality process in place for capturing and maintaining venue information would have a direct impact on the timetable process which makes use of this data.

Once the definitions and processes have been approved, the whole process would need to be communicated to all stakeholders, including academic and administrative departments via top management. Training and documentation on the procedures in place by the CTO, as well as feedback mechanisms would also be necessary. Once all

stakeholders know about the processes, a consistent approach can be followed to implement the timetable as discussed in the case study. Based on the experiences of the individuals using the timetable, feedback must be given to the CTO so that the relevant adjustments can be made if they fall within the timetable policy. Lastly, the quality measures can be evaluated and communicated to all departments by top management. At every stage in the framework, the measures can be assessed to verify the integrity, consistency and timeliness of the data.

The proposed framework and IPMAP can be adjusted to meet the timetabling process followed at any other institution, and similar measures pertinent to each institution can be implemented, making this into a generic framework for managing quality timetable generation.

6.4 Objectives Achieved

The timetabling processes in use at the NMMU were identified (Figure 5.2 & Figure 5.3). These were taken a step further and represented in the form of IPMAP diagrams which made it easier to map quality aspects and measures to the process. The IPMAP approach also had the additional quality of showing ownership and departmental or business area boundaries as well as the sequential flow of data through the timetable process.

The quality aspects that impacted the timetable were identified, being timeliness, accountability, integrity and continuity. These were applied to the timetable process, and the causes of bad timetable quality were identified as being the same causes as highlighted in many other process implementations (Trillium Software, 2006; Vosburg & Kumar, 2001). These were the lack of uniform procedures, a lack of ownership of the data sources and processes, and a lack of common terminology.

The objective of proposing a framework for managing data quality within the NMMU timetable was achieved. This framework can be altered to fit other tertiary institution processes using their own data quality aspects which may be more pertinent to them.

It must be noted that the quality of the timetable is largely influenced by extrinsic factors like ownership, communication and top management involvement, and not only the quality of the data used. This is in line with the quality of the process being satisfactory for the purpose for which it was intended. Therefore quality will be a cumulative effect of all quality aspects pertinent to the process in question.

6.5 Future Research

This dissertation has only investigated the current state of the NMMU timetable. Future studies are necessary to see the effect of implementing the framework at other institutions as well as the success or failure of the framework at the NMMU. The framework can be enhanced to include more of the visual functionality offered by the IPMAP approach (Shankaranarayanan & Cai, 2005) which would make it easier and quicker to see the data quality measures, and therefore a quicker response can be made to quality defects impacting on the timetable.

The effect of a more structured curriculum could also impact on the quality of the timetabling process which would allow an automated timetable to be completed more easily. Different quality aspects would then possibly be more relevant than the ones identified here. A future study could also be done on the generic data qualities relevant to all timetables.

6.6 Conclusion

The background and relevance of this study to the NMMU was provided in the introduction to this chapter, followed by a proposal of a management framework for managing data quality within the NMMU timetable. This has successfully been achieved. Future research has been highlighted on relevant issues related to, but outside the scope of this dissertation.

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APPENDIX A: Layout of Questionnaire

In the questionnaire, the first section will be answered with a weighting of between 1 and 5, with 1 being "Strongly Disagree", and 5 being "Strongly agree". The questions are asked in such a way that a higher rating will be indicative of the importance of the data quality aspect in question. The second section is a general questionnaire to identify the problem areas.

Below, each question is mapped to a section and to a data quality aspect according to which it will be evaluated. In the actual layout of the questionnaire (presented at the end of Appendix A under "Actual Questionnaire on Microsoft SharePoint Site"), the questions are mixed up so as to get a more accurate answer to each question without the users of the questionnaire being influenced by what quality aspect the question relates to.

Questionnaire as Mapped to Data Quality Aspects

Section 1: General

1.1 Are you Academic or Administrative Staff?

1.2 What is your key business area? (E.g. Lecturer, Timetabling, Technical Services, Space Maintenance etc)

1.3 What campus are you on?

1.4 Are you a ex- PET, -UPE, -Vista staff member, or none of the above?

1.5 Department

Section 2: Timetable Requirements

TIMELINESS

Timeliness can be ascertained by whether the timetable is ready on time, and by whether the data required by the timetable is available on time. What are the main target dates each year for the timetable?

2.1 It is very important to have a provisional timetable available before the end of the academic year.

2.2 Generating the timetable once per semester is a beneficial to you.

2.3 It is very important to be able to change or fix the timetable quickly and easily once it has been published.

ACCURACY

Accuracy depicts whether the timetable can be relied upon to give accurate information. For example, can the venues listed in the timetable be related to a physical "address" or "classroom"? Are the periods and times thereof correct? Are all modules displayed on the timetable?

2.4 The venues on the NMMU Lecture timetable do not match the physical building, floor and room numbers on the classrooms themselves.
2.5 You have difficulty finding the classroom, or misinterpreting the time as stated on the timetable.
2.6 The size of the venues allocated are not large enough for the lecture groups.

VALIDITY
Does automated optimisation produce valid results?

2.7 You never use the timetable on the staff portal generated from ITS.
2.8 You always use your own timetable in Excel.
2.9 The timetable generated on the staff portal based on ITS never matches your own timetable in excel.

INTEGRITY
Integrity (who has access to see or change the timetable? Does all the data used in the timetable come from one secure source?).

2.10 The timetable should be available for everyone to see everyone else's timetable schedule.
2.11 You get information required for the lecture timetable from ITS only.
2.12 The venues or academic structure change after the timetable has been set up.

CONSISTENCY
Quality of data is improved through consistency. In other words, if the same processes are used each year, then these processes can be improved upon, rendering more accurate data. Therefore consistency can be determined by whether the same procedures, definitions, and systems are used across the board at the same time, to collect and collate the timetable data.

2.13 You set up your own timetable and ignore the central timetable in O!Time and ITS.
2.14 The NMMU should agree on a standardized time-slot length across all campuses.
2.15 You do not always use the Central Timetabling Office for booking venues.

FLEXIBILITY
Data quality and flexibility are in direct conflict with one another, Therefore a balance needs to be found within the timetable to cater for a certain amount of flexibility (eg. Allowing academics to state preferred venues or times), while retaining the other aspects of data quality like timeliness, validity, consistency, completeness and accuracy.

2.16 You do NOT have the option to change the timetable if it is inaccurate or does not suit your requirements (e.g. Nice-to-haves).
2.17 Before the timetable is set up, you do NOT have the option to negotiate your times or preferred venues.
2.18 Your timetable does not cater for multi-campuses.

COMPLETENESS
As is quite often the case, data often has no use if it is not complete. Are all venues and modules represented? Of what use would a timetable without times be for a student, or how can the timetable be optimised if not all the venues are listed? This also has an impact on timetable reporting to the DoE as space usage.

2.19 There are modules or venues that you are aware of that do not appear on the central office timetable (e.g. O!Time, ITS, Student & Staff portal timetables).
2.20 You don't bother reporting missing data or dedicated venues (e.g. venues, modules or extra classes) to the timetabling office.
2.21 The Department of Education is not interested in Lecture venue usage and timetable data for subsidy purposes.

EASE OF USE
Even if the timetable has brilliant quality data, it can be rendered useless if it cannot be easily accessed or used. For example, how much of the data can be automatically taken from the system without having to add data manually?

2.22 It is difficult or impossible to access and download into excel the timetable generated by O!Time or from ITS.
2.23 It is difficult or impossible to get or view a timetable for the other campuses.
2.24 There should be only one method of communicating (e.g. electronic on-line form) and scheduling the timetable requirements with the central timetable office.

ACCOUNTABILITY
Accountability relates to ownership. Who's responsibility is it to maintain and provide an accurate timetable? Are all the "feeder" data sources maintained by the same section, or will the quality of these systems ultimately have an effect on the end result?

2.25 It should totally be the central timetable office's responsibility to maintain an accurate timetable.
2.26 It is the lecturer's responsibility to provide accurate, timely information (for example, dedicated venues, preferences, academic structure modules) in order for an accurate timetable to be maintained.
2.27 It is vital for the owners of the data sources underlying the timetable (e.g. Academic structure, Space system, lecturers) to be accountable to the timetable office in order to produce an accurate timetable.

ACCESSIBILITY
Can everyone access the timetable data that they need to use?
2.28 You cannot automatically or easily retrieve or view the information that the timetable is based on (e.g. Venues, periods, lecturers, Modules etc) in order to verify or set up a timetable.

2.29 Your own departmental timetable is NOT available to students or other departments.
2.30 The ITS timetable is NOT available to students or other departments.

Section 3: Causes for bad Timetable Quality

DATA INTERPRETATION

As stated above, academic staff and administrative staff have different goals in mind when it comes to the timetable. Therefore the data is interpreted in different ways, not only by academic and admin staff, but also possibly between campuses, programs and delivery modes. Data interpretation asks the question: What problem has the information solved for you? Conformance to specification?

3.1 What is the main purpose that you use the lecture timetable for?

* Scheduling lecture times, venues and staff
* Space usage
* Statistical reporting

3.2 Does the timetable give you all the information that you are looking for?

* Yes * No

If No, what has been left out…?

3.3 What problem has the timetable solved, or not solved, for you?

OWNERSHIP

By various departments owning different sections of data required by the timetable, it means that data quality can vary between sections, and ultimately have an impact on the final timetable produced.

3.4 What section of the timetable are you responsible for?

* Maintaining Venues
* Maintaining the academic structure
* Giving feedback to Academic Admin when modules or delivery modes change, to Technical Services when new venues or their attributes change, or to the Timetable office regarding dedicated venues and your lecturing requirements
* Maintaining and generating the main timetable
* Maintaining an individual timetable for a specific campus
* Other section…

3.5 How do you communicate with other departments regarding the setup of your timetable and resolving clashes?

3.6 What problems will a central timetable cause for you?

UNIFORM TECHNOLOGY

Does all the data come from the same database, or is it manipulated along the way by other programs or systems or manually? The more interfaces the data has to go through before reaching the end result, causes there to be more margin for error, thereby reducing the quality of the data.

3.7 If you are setting up a timetable, or providing information to the Central Timetabling Office, where do you get most of your information from?

* ITS
* Celcat
* Excel
* O!Time
* Other (Please specify…)

3.8 Do you have to do a data clean-up before you can use the data? (i.e. convert it into another format)? Please explain...
3.9 Do you have to capture the timetable more than once? (For example, in your own system, like excel, as well as into ITS, O!Time or other system). Please specify where you do capture it…

UNIFORM PROCEDURES
Does everyone follow the same process for capturing data, or is there more than one way to do the job? On the other end of the process, is there one point of access, or is the same information delivered in various places, possibly for different purposes, opening gaps for erroneous interpretation of the data?

3.10 What process do you follow to get a timetable – briefly?
3.11 Can students access their own timetables in your department?
3.12 How many different places can you access the lecture timetable in order to query or print it?
* Staff Portal # * Student Portal # * Kiosk# * ITS # * Excel # * Other # *MIS# * BI# * O!Time
3.13 Do you experience clashes between various timetables, and how do you recommend going about resolving them?
3.14 Are you aware of any specific policies impacting on the lecture timetable?
If yes, please specify which policies….?
3.15 Are you aware of anything that would have an impact on the lecture timetable (For example, NQF credit changes…)?

COMMON TERMINOLOGY
Is it possible for headings to be misleading about the content of the information? Are a uniform set of definitions or formulas being used for the timetable? For example, building naming conventions.

3.16 What do you call the lecture timetable in your department?
3.17 Are there venues that you refer to by a different name to what appears on the door, in ITS, or on the Timetable? If yes, please give an example…
3.18 Do you have another name for :
* Class groups (A)
* Group Types (Tutorial, Practical, Class)
* Offering Types (01, A1)
* Block codes
* Any combination of these…

3.19 Do you use the module/subject codes, the module brief description, full description, or your own description?

Actual Questionnaire as on Microsoft SharePoint Site

The first 5 questions are general questions; thereafter the questions are weighted from "Strongly Disagree" to "Strongly Agree". Please select one. If you are not sure, please check the "Neither Agree or Disagree" check button.

The last part of the questionnaire is to identify potential areas or reasons for bad timetable data quality. Please answer them as briefly, but as accurately as possible. All responses to this survey are anonymous.

Timetable data quality Survey: Respond to this Survey

* indicates a required field

Are you Academic or Administrative Staff? *

- (•) Academic
- ( ) Admin

What is your key business area? *

- [x] Lecturer
- [ ] Timetabling
- [ ] Technical Services
- [ ] Space maintenance
- [ ] Academic Administration
- [ ] Specify your own value:

What campus are you on? *

- ( ) North campus
- ( ) South campus
- ( ) Missionvale campus
- ( ) George campus
- ( ) 2nd Avenue campus

- Specify your own value:

Are you a ex- PET, -UPE, -Vista staff member, or none of the above? *

- Ex-UPE
- Ex-PET
- Ex-Vista
- NMMU
- Other

Department *

It is very important to have a provisional timetable available before the end of the academic year. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

The venues on the NMMU Lecture timetable do not match the physical building, floor and room numbers on the classrooms themselves. *

- Strongly Disagree
- Disagree
- Neither Agree Nor Disagree
- Agree
- Strongly Agree

You never use the timetable on the staff portal generated from ITS. *

- Strongly Disagree
- Disagree
- Neither Agree Nor Disagree

- Agree
- Strongly Agree

The timetable should be available for everyone to see everyone else's timetable schedule. *

- Strongly Disagree
- Disagree
- Neither Agree Nor Disagree
- Agree
- Strongly Agree

You set up your own timetable and ignore the central timetable in O!Time and ITS. *

- Strongly Disagree
- Disagree
- Neither Agree Nor Disagree
- Agree
- Strongly Agree

You do NOT have the option to change the timetable if it is inaccurate or does not suit your requirements (eg. nice-to-haves). *

- Strongly Disagree
- Disagree
- Neither Agree Nor Disagree
- Agree
- Strongly Agree

There are modules or venues that you are aware of that do not appear on the central office timetable (eg. O!Time, ITS, Student & Staff portal timetables). *

- Strongly Disagree
- Disagree
- Neither Agree Nor Disagree
- Agree

- Strongly Agree

It is difficult or impossible to access and download into excel the timetable generated by O!Time or from ITS. *

- Stongly Disagree
- Disagree
- Neither Agree Nor Disagree
- Agree
- Strongly Agree

It should totally be the central timetable office's responsibility to maintain an accurate timetable. *

- Stongly Disagree
- Disagree
- Neither Agree Nor Disagree
- Agree
- Strongly Agree

You cannot automatically or easily retrieve or view the information that the timetable is based on (eg. Venues, periods, lecturers, Modules etc) in order to verify or set up a timetable. *

- Stongly Disagree
- Disagree
- Neither Agree Nor Disagree
- Agree
- Strongly Agree

Generating the timetable once per semester is a beneficial to you. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

You have difficulty finding the classroom, or misinterpreting the time as stated on the timetable *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

You always use your own timetable in Excell. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

You get information required for the lecture timetable from ITS only. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

The NMMU should agree on standardizing time-slot lengths accross all campuses. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

Before the timetable is set up, you do NOT have the option to negotiate your times or preferred venues. *

- Strongly Disagree

- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

You don't bother reporting missing data or dedicated venues(eg. venues, modules or extra classes) to the timetabling office. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

It is difficult or impossible to get or view a timetable for the other campuses. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

It is the lecturer's responsibility to provide accurate, timely information (for example, dedicated venues, preferences, academic structure modules) in order for an accurate timetable to be maintained. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

Your own departmental timetable is NOT available to students or other departments. *

- Strongly Disagree
- Disagree

- Neither Agree nor Disagree
- Agree
- Strongly Agree

It is very important to be able to change or fix the timetable quickly and easily once it has been published. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

The size of the venues allocated are not large enough for the lecture groups. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

The timetable generated on the staff portal based on ITS never matches your own timetable in excel. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

The venues or academic structure change after the timetable has already been set up. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree

- Strongly Agree

You DO NOT always use the Central Timetabling Office for booking venues. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

Your timetable does NOT cater for multi-campuses. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

The Department of Education is not interested in Lecture venue usage and timetable data for subsidy purposes. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

There should be only one method of communicating (eg. electronic on-line form) and scheduling the timetable requirements with the central timetable office. *

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

It is vital for the owners of the data sources underlying the timetable (eg. Academic structure, Space system, lecturers) to be accountable to the timetable office in order to produce an accurate timetable. *

- ○ Strongly Disagree
- ○ Disagree
- ○ Neither Agree nor Disagree
- ○ Agree
- ○ Strongly Agree

The ITS timetable is NOT available to students or other departments. *

- ○ Strongly Disagree
- ○ Disagree
- ○ Neither Agree nor Disagree
- ○ Agree
- ○ Strongly Agree

What is the main purpose that you use the lecture timetable for? *

- ☐ Scheduling lecture times, venues and staff
- ☐ Space usage
- ☐ Statistical reporting
- ☐ Specify your own value:

Does the timetable give you all the information that you are looking for?

- ☑

If No, what has been left out…?

What problem has the timetable solved, or not solved, for you? *

What section of the timetable are you responsible for? *

- ☐ Maintaining Venues
- ☐ Maintaining the academic structure
- ☐ Giving feedback to Academic Admin when modules or delivery modes change, to Technical Services when new venues or their attributes change, or to the Timetable office regarding dedicated venues and your lecturing requirements
- ☐ Maintaining and generating the main timetable
- ☐ Maintaining an individual timetable for a specific campus
- ☐ Other …
- ☐ Specify your own value:

How do you communicate with other departments regarding the setup of your timetable and resolving clashes? *

What problems will a central timetable cause for you? *

If you are setting up a timetable, or providing information to the Central Timetabling Office, where do you get most of your information from? *

- ☐ ITS

- [ ] Celcat
- [ ] Excell
- [ ] O!Time
- [ ] Specify your own value:

Do you have to do a data clean-up before you can use the data? (i.e. convert it into another format)? Please explain.. *

Do you have to capture the timetable more than once? (For example, in your own system, like excel, as well as into ITS, O!Time or other system). Please specify where you do capture it… *

What process do you follow to get a timetable – briefly? *

Can students access their own timetables in your department? *

How many different places can you access the lecture timetable in order to query or print it? *

- [ ] Staff Portal
- [ ] Student Portal

- [ ] Kiosk
- [ ] ITS
- [ ] Excell
- [ ] O!Timetable
- [ ] MIS
- [ ] BI
- [ ] Specify your own value:

Do you experience clashes between various timetables, and how do you recommend going about resolving them? *

Are you aware of any specific policies impacting on the lecture timetable? *

- ( ) Yes
- ( ) No

If yes, please specify which policies?

Are you aware of anything that would have an impact on the lecture timetable? (For example, NQF credit changes...) *

What do you call the lecture timetable in your department? *

Are there venues that you refer to by a different name to what appears on the door, in ITS, or on the Timetable? If yes, please give an example… *

Do you have another name for : * Class groups (A) *

Do you have another name for : * Group Types (Tutorial, Practical, Class) *

Do you have another name for : * Offering TypeS (01, A1) *

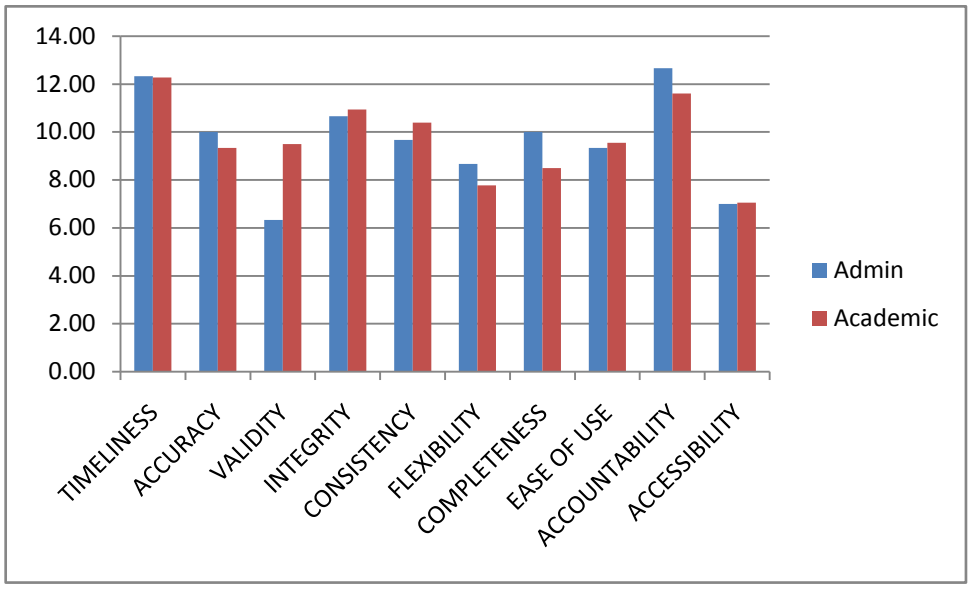
Do you have another name for : * Block codes *

Do you have another name for : * Any combination of the above... *

Do you use the module/subject codes, the module brief description, full description, or your own description? *

APPENDIX B: Research Results

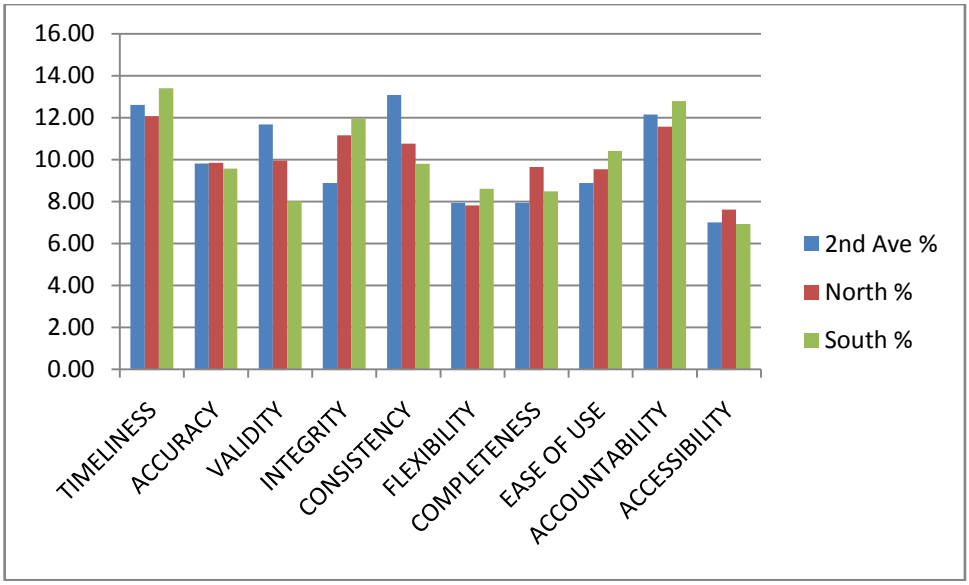
Top Data Quality Aspects for the NMMU Timetable (Research Question 2)



Perceived impact of data quality aspects on the NMMU timetable for Academics and Administrative staff.

	All	Admin	Academic
TIMELINESS	12.29	12.33	12.28
ACCURACY	9.43	10.00	9.33
VALIDITY	9.05	6.33	9.50
INTEGRITY	10.90	10.67	10.94
CONSISTENCY	10.29	9.67	10.39
FLEXIBILITY	7.90	8.67	7.78
COMPLETENESS	8.71	10.00	8.50
EASE OF USE	9.52	9.33	9.56
ACCOUNTABILITY	11.76	12.67	11.61
ACCESSIBILITY	7.05	7.00	7.06

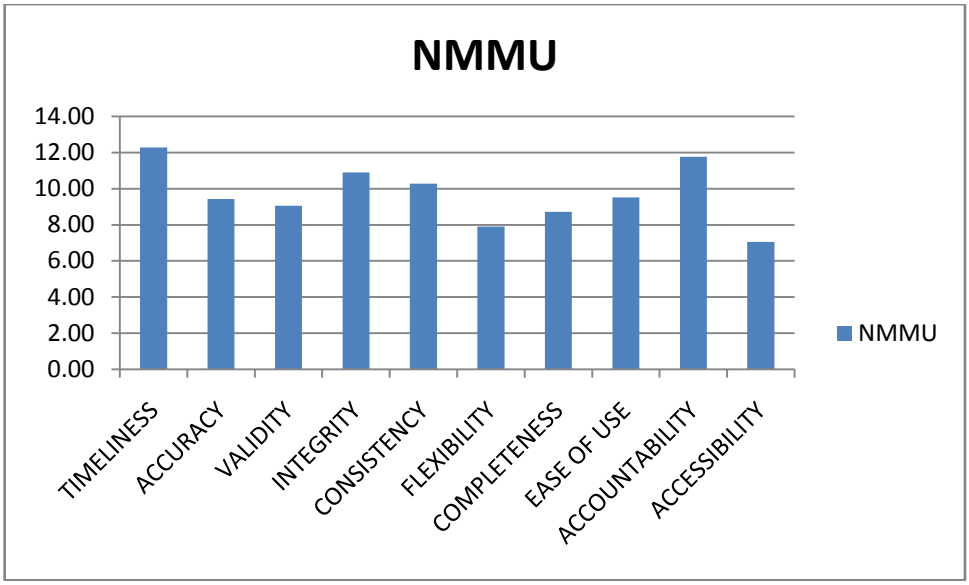
Percentages for data quality aspects most pertinent to the NMMU for Academic and Administrative staff.



Data quality aspects most pertinent to the various campuses.

Quality Aspects	2nd Ave %	North %	South %
TIMELINESS	12.62	12.08	13.40
ACCURACY	9.81	9.85	9.57
VALIDITY	11.68	9.95	8.01
INTEGRITY	8.88	11.17	11.96
CONSISTENCY	13.08	10.76	9.81
FLEXIBILITY	7.94	7.82	8.61
COMPLETENESS	7.94	9.64	8.49
EASE OF USE	8.88	9.54	10.41
ACCOUNTABILITY	12.15	11.57	12.80
ACCESSIBILITY	7.01	7.61	6.94

Percentages for data quality aspects most pertinent to the various campuses at the NMMU.



Percentages for overall data quality aspects for the NMMU Timetable

State of the Current Timetable at the NMMU (Research Question 3)

Perceived Causes for bad Timetable Quality

DATA INTERPRETATION (questions 3.1 to 3.3 of questionnaire)

As stated above, academic staff and administrative staff have different goals in mind when it comes to the timetable. Therefore the data is interpreted in different ways, not only by academic and admin staff, but also possibly between campuses, programs and delivery modes. Data interpretation asks the question: What problem has the information solved for you? Conformance to specification?

3.1

What is the main purpose that you use the lecture timetable for?	**%**
Scheduling lecture times, venues and staff	65.38
Space usage	11.54
Statistical reporting	15.38
I never use the its timetable, as we have dedicated venues with our own internal timetable	7.69

3.2 Does the timetable give you all the information that you are looking for?

*** Yes * No**

If No, what has been left out…?

76% responded that the timetable provided all the information they were looking for, while 24% said not, with the following reasons why:

- Venue type: specifically whether fixed furniture or not (Academic, Enviro Health & Soc Dev Professions, SC)
- On ITS under module : the venue and times are given but not the size of the venue. One needs to click on the venue timetable to get this information. Could this not be part of the ITS module timetable. Also whether data projecter or not. (Mathematics and Applied Mathematics, Academic, SC, Scheduling lecture times, venues and staff)
- Would be nice to only print the campus I need using the staff portal. Maybe I just need to be shown how (Admin, Space, Physical Planning, NC, , Space & Statistics)
- The friendly and extremely helpful assistance by the (Central)Timetable persons (Academic, Physics, SC, Scheduling lecture times, venues and staff)
- We use our own timetables so I can't answer this question (Academic, Civil, NC, Scheduling lecture times, venues and staff)
- HARD TO UNDERSTAND 'DUPLCATE' LECTURE REFERENCES. TIMETABLE SHOULD INDICATE THE NO. OF CLASS GROUPS AND WHICH ARE ACCOMMODATED TOGETHER IN A SPECIFIC VENUE AT A SPECIFIC TIME, ETC. ALSO NEEDS TO BE CLEARER IN EVENT OF MODULES HAVING DIFFERENT CODES, BUT LINKED I.E. OCCURING AT THE SAME TIME/VENUE. LAB VENUES ARE NOT ALWAYS SPECIFIED BUT IS DIFFICULT TO DO BEFORE THE TERM BEGINS AND SHOULD NOT BE ATTEMPTED (SOME E.G. PRACS ARE DONE BY GROUPS SMALLER THAN THE CLASS GROUP, ON DIFFERENT DAYS ETC. TOO DIFFICULT TO TRY AND INCLUDE THIS SORT OF EVENTUALITY IN A CENTRAL TIMETABLE). (Academic, Mechatronics, NC, Scheduling lecture times, venues and staff)
- The space data on the ITS system has not been corrected according to the North Campus, I think. (Academic, Information Technology, NC)
- The venue numbers on North Campus do not correspond with the numbers that we have been using and that are on the doors of the venues. In general I find the layout on the web very confusing and it takes a long time to find things and work out a time table for a new student that comes to ask questions about it. (Academic, Chemistry, Program Manager, Lecturer, NC)

3.3 What problem has the timetable solved, or not solved, for you?

Administration (Space maintenance, Academic Admin, ICT)

Space usage and Statistical Reporting.

No information regarding dedicated venues with modules given in them
Producing centralized information about timetabling across campsues fro the first time ever.
Lack of all timetable data on ITS causes a reporting problem and a data provision problem

Academic

Scheduling lecture times, venues and staff.

2nd Avenue campus	Applied Accounting	Solved my time-table problems myself.
2nd Avenue campus	Applied Language Studies	Finding alternative venues
North campus	studio arts	na
North campus	Bldg & QS	-
North campus	civil	nothing to add

North campus	Electrical Eng	Large class groups - more than 60 seats. Currently there are not enough bigger lecture rooms on the North campus
North campus	Nursing Scince	Has not solved my clashes with the department of engineering. the class size and type is not always suitable for the class. I also cannot have the consercutive periods (four to five) as needed for the department as our students also have to fulfil the legal requirement of working certain amount of clinical hours per week to a year up to the end of their training.it therefore need us to have our students on average two days on campus and have the rest of the days in clinica each week. the timetable does not give us if it does we are to move from class to class thus wasting a lot of time by moving as well as distracting the line of thaught of the lecture.
South campus	Journalism, Media and Philosophy	N/A
South campus	Physics	Solving : Changing of pre-booked Test Venues when it turned out that the number of students in the class has increased to a larger number than I expected.
South campus	Business Management	Time talbe stays the same year after year and Business Management must always struggle to get the big venues at decent times - we lecture late afternoons and students get annoyed - why can o time table not work and allocate the venues in another way than currently - like it was in the past
South campus	Faculty of Education	service faculty TT
South campus	Environmental Health & Social Development Professions	The venue crisis - We cater for very large numbers and sometimes we need venue with movable furniture for skills and practical purposes and this is not always the case when venues are allocated
South campus	Intermediate Phase	easy access to other department's data
North campus	MECHATRONICS	IT DOESN'T REALLY SLOVE ANYTHING, BECAUSE WE HAVE TO REALLY SET UP OUR OWN BECASUE TOO COMPLICATED TO SPECIFY ALL DETAILS/REQUIREMENTS FOR DIFFERENT MODULES E.G. SOME WEEKS THE PATTERN DOES NOT GET REPEATED I.E. DON'T ALWAYS HAVE A PRAC ON THAT DAY AT THAT TIME. ALSO THINGS CHANGE AS THE TERM UNFOLDS. STUDETN NUMBERS CAN ALSO CHANGE AND CAUSE PROBLEMS.
North campus	Information Technology	So far, it does not give us a total timetable because when we prepare and submit our Excel spreadsheet, it is NOT captured at all into ITS, and the reason given is that the space data for North campus is wrong. When is this data going to be corrected? Otherwise it is very useful for booking shared venues.
North campus	Chemistry	We did not use the ITS time table on the web, but rather our own this year. I only discoverd that parts of

		our time table are actually on the ITS generated one on the website a few weeks ago by accident. It is also inaccurate inb places and some info has been left out. The venue numbers on the time table for north campus are simply from another planet and there is no explanation for it, so we just use the ones we know and that we have been using all these years.
South campus	Enviro Health & Soc Dev Professions	Just takes the hassle out of managing across the programmes
South campus	Mathematics and Applied Mathematics	Timetable cannot solve problems : the management of the timetable and venues is staff driven.

OWNERSHIP

By various departments owning different sections of data required by the timetable, it means that data quality can vary between sections, and ultimately have an impact on the final timetable produced.

3.4 What section of the timetable are you responsible for?

- **Maintaining Venues**
- **Maintaining the academic structure**
- **Giving feedback to Academic Admin when modules or delivery modes change, to Technical Services when new venues or their attributes change, or to the Timetable office regarding dedicated venues and your lecturing requirements**
- **Maintaining and generating the main timetable**
- **Maintaining an individual timetable for a specific campus**
- **Other section…**

Administrative Staff:

Use information for reporting purposes
Space
Maintaining and generating the main timetable

Academic Staff:

2nd Avenue –

Applied Accounting	Maintaining Venues;#Maintaining an individual timetable for a specific campus
Applied Language Studies	Maintaining Venues;#Maintaining an individual timetable for a specific campus;#Other …;#Maintaining timetables for 2nd Ave and NC

North Campus –

studio arts	Maintaining an individual timetable for a specific campus;#as per own dedicated space
Bldg & QS	Other …

civil	Maintaining and generating the main timetable;#complete timetable for Civil engineering
Electrical Eng	Maintaining Venues;#Maintaining an individual timetable for a specific campus
Nursing Scince	Maintaining Venues;#Giving feedback to Academic Admin when modules or delivery modes change, to Technical Services when new venues or their attributes change, or to the Timetable office regarding dedicated venues and your lecturing requirements;#Maintaining and generating the main timetable
MECHATRONICS	MAINTAINING TIMETABLE FOR OUR DEPT. ONLY (INCL. VENUES)
Information Technology	Other …;#Own Dept Timetable
Chemistry	Maintaining the academic structure;#Maintaining an individual timetable for a specific campus;#Liasing with staff in service course departments with regards to their time tables.

South Campus –

Journalism, Media and Philosophy	Giving feedback to Academic Admin when modules or delivery modes change, to Technical Services when new venues or their attributes change, or to the Timetable office regarding dedicated venues and your lecturing requirements
Physics	Informing students and staff about lecture venues
Business Management	lecturer
Faculty of Education	Maintaining the academic structure
Environmental Health & Social Development Professions	Other …
Intermediate Phase	Other …;#maintaining Fac of Ed timetable
Enviro Health & Soc Dev Professions	Providing feedback on behalf of the programmes I lead to the timetabling office when currriculum changes are made
Mathematics and Applied Mathematics	Giving feedback to Academic Admin when modules or delivery modes change, to Technical Services when new venues or their attributes change, or to the Timetable office regarding dedicated venues and your lecturing requirements;#I am merely a member of the department who deals with timetable issues.

3.5 How do you communicate with other departments regarding the setup of your timetable and resolving clashes?

Administrative –

ICT	I do not
Physical Planning - Technical Services	Via ICT and Timetabling
Academic Administration	E-mail, personal meetings

Academic – 2nd Avenue

Applied Accounting	Telephonic
Applied Language	Meet with cnetraol TT coordinators for 2nd Ave and NC

Studies	

- **North**

studio arts	na
Bldg & QS	-
civil	personal discussions & email
Electrical Eng	Allocate time slots before I start with the time table. Slots are generally the same for service departments for every semester
Nursing Scince	By phone or electronical messages via the central timetabling office
MECHATRONICS	BY EMAIL
Information Technology	Liaise with about 6 lecturers from other departments, but otherwise all is in-house with our own lecturers.
Chemistry	By contacting the person responsible for the time table in each department and liasing with them to solve problems

- **South**

Journalism, Media and Philosophy	Email
Physics	Email/Telephone
Business Management	e-mail and phone
Faculty of Education	yes
Environmental Health & Social Development Professions	Through the timetable office
Intermediate Phase	email
Enviro Health & Soc Dev Professions	This has become increasingly difficult as it just seems to be free for all at the moment and where a few years ago there were no clashes, we now have core modules clashing
Mathematics and Applied Mathematics	through central timetabling : Mandisa Magau.

3.6 What problems will a central timetable cause for you?

Campus	**Dept**	
2nd Avenue campus	Applied Accounting	Time to make changes to an existing time-table
2nd Avenue campus	Applied Language Studies	Lecture allocation times, venue sizes
North campus	studio arts	na
North campus	Bldg & QS	-
North campus	civil	we are short of staff, and sometimes only find a suitable lecturer a week before lectures start. We need to be flexible.
North campus	Electrical Eng	Flexibility and practical sessions will be difficult to schedule. They have tried in the past and it did not work as there are too many variables!
North campus	Nursing Scince	none
South campus	Journalism, Media and Philosophy	No problems as long as its accurate.

South campus	Physics	If it is very rigid, and cannot be changed (see my comment about changing venues that the Timetable persons effected for me this year).
South campus	Business Management	Hopefully it will rather solve my problems
South campus	Faculty of Education	felxibility
South campus	Environmental Health & Social Development Professions	None
South campus	Intermediate Phase	none if it can be set up properly - but I understand the difficulties that are enormous - we just have too many modules
North campus	ICT	It will solve problems
North campus	Physical Planning - Technical Services	None
South campus	Academic Administration	None
North campus	MECHATRONICS	SEE ANSWERS TO 'WHAT HAS BEEN LEFT OUT' AND 'WHAT PROBLEM HAS THE TIMETABLE SOLVED', ABOVE.
North campus	Information Technology	No problems. It will probably help us with providing venues that fit our numbers of students.
North campus	Chemistry	Possibly the moving of venues far away from our offices and training laboratories, moving our lectures to venues that are not suitable to our course structure. Other wise I think it is a great idea. Other problems may arise, but we can only know tht once we have implemented the time table.
South campus	Enviro Health & Soc Dev Professions	Change is never easy! but I feel strongly that we need to walk this road and have a trial run to iron out the kinks
South campus	Mathematics and Applied Mathematics	If staff unavailable then problems created. Should have sufficient staff to deal with timetable issues at all times.

UNIFORM TECHNOLOGY

Does all the data come from the same database, or is it manipulated along the way by other programs or systems or manually? The more interfaces the data has to go through before reaching the end result, causes there to be more margin for error, thereby reducing the quality of the data.

3.7 If you are setting up a timetable, or providing information to the Central Timetabling Office, where do you get most of your information from?

- **ITS**
- **Celcat**
- **Excel**

* **O!Time**
* **Other (Please specify…)**

Technology	%
ITS	32
Celcat	4
Excel	16
O!Time	4
Staff Portal/Intranet	8
Other	36

Other sources of information for setting up departmental timetables include:

- the APQC document (Environ. Health & Soc Dev Professions),
- consulting with other departments (Applied Language Studies),
- internal programmes (studio arts),
- past timetables already set up to meet their unique course structure(civil, Chemistry),
- own information and past experience (Electrical Eng),
- consulting lecturers (Business Management), and
- own departmental staff (MECHATRONICS).

3.8 Do you have to do a data clean-up before you can use the data? (i.e. convert it into another format)? Please explain..

80% do not need to clean-up data as it is not necessarily relevant to them, while 20% are involved in cleaning data.

- These involve academics (Applied Language) who use "Use DALS TT formats" ,
- "I make hard copies and take them up with me to the timetabling centre for the discussion of changes and requests" (Nursing Scince),
- "Someone has to clean up the space data for the North Campus on ITS" (Information Technology), and
- administrative staff (Academic Administration).

3.9 Do you have to capture the timetable more than once? (For example, in your own system, like excel, as well as into ITS, O!Time or other system). Please specify where you do capture it…

48% do not have to capture data into more than one place, and 52% have needed to. Of those that have had to recapture data, more than half have recaptured into Excel, and the rest into Word, ITS or O!Time.

Excel	58.333
Word	16.667
ITS	8.3333
O!Time	16.667

UNIFORM PROCEDURES

Does everyone follow the same process for capturing data, or is there more than one way to do the job? On the other end of the process, is there one point of access, or is the same information delivered in various places, possibly for different purposes, opening gaps for erroneous interpretation of the data?

3.10 What process do you follow to get a timetable – briefly?

Acad_Admin	Campus	Dept	UNIFORM PROCEDURES
Academic	2nd Avenue campus	Applied Accounting	Work throught every subject for every programme to ensure it is captured and that there is no clashes.
Academic	2nd Avenue campus	Applied Language Studies	Meet with TT coordinators from various dept for which DALS provides service subjects
Academic	North campus	studio arts	na
Academic	North campus	Bldg & QS	ITS
Academic	North campus	civil	look at past timetables that have worked. Try to use the same timetable for the next semester. If there are changes in lecturers, then I need to manually adjust it.
Academic	North campus	Electrical Eng	Use a key system and then generate an excell sheet. It is simple and convenient for our department
Academic	North campus	Nursing Scince	tRACE BY DEPARTMENT AND VENUES
Academic	South campus	Journalism, Media and Philosophy	Use the Intranet.
Academic	South campus	Physics	Go to Intranet - Staff portal
Academic	South campus	Business Managemen t	N/A
Academic	South campus	Faculty of Education	MIS then TT
Academic	South campus	Environment al Health & Social	Access it through online

		Developmen t Professions	
Academic	South campus	Intermediate Phase	use our MIS system, ITS timetable for other departments and our specialised venues
Admin	North campus	ICT	Extract the infomation from ITS
Admin	North campus	Physical Planning - Technical Services	n/a
Admin	South campus	Academic Administrati on	Reqeust info for academics, send it to the CTO
Academic	North campus	MECHATRON ICS	GETS HABDED TO STUDENTS ON FIRST DAY OF TERM, OR EMAILED TO THEM PRIOR TO THAT, OR GIVEN OUT AT ORIENTATION.
Academic	North campus	Information Technology	Collect info from HOD as to who teaches what, how many lectures and pracs etc. Then I use the venues allocated to our Dept, and also book some of the shared venues with CTO. Then I prepare the timetable manually on Excel
Academic	North campus	Chemistry	We design our own time tables for the DIploma and B Tech programmes in the Department of Chemistry and then print them out.
Academic	South campus	Enviro Health & Soc Dev Professions	ITS and central timetabling
Academic	South campus	Mathematics and Applied Mathematics	ITS

3.11 Can students access their own timetables in your department?

85% of all respondents said their students could access their own timetables, and 15% said no.

- TTs are put up for display
- YES.It is displayed on our notice boards and they are also provided of the copy on registration
- ES (NOT INDIVIDAULLY THOUGH - BY YEAR GROUP)
- Yes, they are given copies at the beginning of each semester and also receive any updates and changes via e-mail and on the course websites (Chemistry)

3.12 How many different places can you access the lecture timetable in order to query or print it?

*** Staff Portal # * Student Portal # * Kiosk# * ITS # * Excell # * Other # *MIS# * BI# * O!Time**

Timetable Sources	%
Staff Portal	41.18
Student Portal	8.82
Kiosk	2.94
ITS	5.88
Excel	8.82
MIS	5.88
BI	0.00
O!Time	14.71
Other	11.76

Other sources:

- Secretary
- we print it out for the students @ registration
- Send a copy to all Electrical students
- DEPARTMENTAL SHAREPOINT SITE (AND I SUPPOSE STUDENT PORTAL IF CENTRAL TIMETABLE IS IN 4MENT WITH OUR OWN)
- I did no know that it is possible to access lecture time tables from most of the above sources and do not have access to them or know how to access them
- Question vague : are you referring to me personally or in general ? As far as I know student portal also gives the IT module timetable.

3.13 Do you experience clashes between various timetables, and how do you recommend going about resolving them?

62% of respondents experience venue clashes due to the timetable, while 38% do not.

How do they resolve them:

- contacting various depts for variations and changes (very manual). (Applied Language Studies)
- Contact ICT (Bldg & QS)
- Discuss & email (Civil)
- Central timetabling is usually assisting me but there are a lot of challenges and we end up at times without venues but use our clinical laboratory which is totally non-conducive to teaching (Nursing Science)
- mostly between different year levels (e.g. a first year subject and a thirdy ear subject) (Journalism/Media)

- Having a sword fight at the break of dawn, alternatively hanging yourself by your tie in your office before morning coffee. Otherwise, phone the Timetable people, and discuss the problem with them (Physics)
- if clashes central timetable takes precidencs (Intermediate Phase)
- hos TT's not yet on ITS creates venue clashes as the CTO does not know about the venue usage. (Academic Admin)
- MOSTLY VENUE CLASHES. IN OUR CASE, ASSIGN A FEW (SMALL) LECTURE VENUES TO OUR SPECIFIC DEPT. - WE WOULD THEN BE GIVEN FIRST PRIORITY ON THESE, AND WOULD (Mechatronics)
- We have experienced clashes with other departments who have NOT gone to CTO to book the shared venues such as N1, N2 etc on North Campus. We did our booking with CTO, but other departments assumed "status quo" and did not book as requested. We tried to accommodate them as much as possible in the first semester, but then sent them to CTO. (Information Technology)
- We have experineced clashes, but it has always been possible to resolve them amicably amongs staff and service departments. (Checmistry)

3.14 Are you aware of any specific policies impacting on the lecture timetable? If yes, please specify which policies….?

NMMU Policy Awareness: 33% are aware of policies in existence, but no necessarily the content or which ones they are. 67% do not know that NMMU policies governing the timetable processes and content exist.

Policies that were identified were:

- Central timetableing policy (Intermediate Phase),
- Timetabling Policy & Academic Facilities Management Policy (Academic Administration),
- NMMU policy (Enviro Health & Soc Dev Professions),
- "The policies to help get o!timetable. Length of periods etc. I thought there was policy for test bookings : eg science faculty have a test roster." (Mathematics and Applied Mathematics), and
- "Periods that are allocated to SRC" (Electrical Engineering).

3.15 Are you aware of anything that would have an impact on the lecture timetable (For example, NQF credit changes…)?

Dept	Anything having an Impact on Timetable
Applied Accounting	No
Applied Language Studies	revealing actual classes taken / staff member.
studio arts	Na
Bldg & QS	-
civil	yes, it tells me how many lectures per subject to schedule.
Electrical Eng	Yes the credit values of all modules in the Elec Eng department

Nursing Scince	yes. in my department as stated already it will have major implications with the required number of clinical hours as well as the theoretical hours if it is not well managed
Journalism, Media and Philosophy	No
Physics	No
Business Management	Class sizes
Faculty of Education	No
Environmental Health & Social Development Professions	NO
Intermediate Phase	No
ICT	Vwnue size to small
Physical Planning - Technical Services	n/a
Academic Administration	Curriculum design, Module combinations, New programmes, New NQF structures
MECHATRONICS	ECSA (ENGINEERING COUNCIL OF SA) REQUIREMENTS IN TERMS OF 'CONTACT' TIME WITH STUDENTS.
Information Technology	I dont have access to this sort of information
Chemistry	Yes, we have to recurriculate our qualification according to the new HEQF and that will definitely have an impact on the time table.
Enviro Health & Soc Dev Professions	No
Mathematics and Applied Mathematics	No

COMMON TERMINOLOGY

Is it possible for headings to be misleading about the content of the information? Are a uniform set of definitions or formulas being used for the timetable? For example, building naming conventions.

3.16 What do you call the lecture timetable in your department?

Campus	Dept	COMMON TERMINOLOGY
2nd Avenue campus	Applied Accounting	Lecture time -table
2nd Avenue campus	Applied Language Studies	Teaching Timetable?
North campus	studio arts	timetable
North campus	Bldg & QS	Lecture Timetable
North campus	civil	timetable
North campus	Electrical Eng	Timetable semester 1-2008 or 2-2008

North campus	Nursing Scince	TIMETABLES/ALLOCATIONS
North campus	MECHATRONICS	TIMETABLE
North campus	Information Technology	The Department timetable, I suppose, or else "Timetable for IT"
North campus	Chemistry	We have three: The A1 Time table, A2 time table, A3 Time Table and B Tech Time Table
South campus	Journalism, Media and Philosophy	The timetable?
South campus	Physics	Lecture Timetable
South campus	Business Management	Time table
South campus	Faculty of Education	BEd and PGCE time tables
South campus	Environmental Health & Social Development Professions	???
South campus	Intermediate Phase	Timetable
South campus	Enviro Health & Soc Dev Professions	the official timetable
South campus	Mathematics and Applied Mathematics	timetable
South campus	Academic Administration	Lecture Timetable
North campus	ICT	timetable
North campus	Physical Planning - Technical Services	lecture timetable

3.17 Are there venues that you refer to by a different name to what appears on the door, in ITS, or on the Timetable? If yes, please give an example…

Dept	**COMMON TERMINOLOGY**
Applied Accounting	No
Applied Language Studies	X018 2nd Ave - Absa Lab
studio arts	Na
Bldg & QS	No
civil	No
Electrical Eng	No
Nursing Scince	NO
Journalism, Media and Philosophy	No
Physics	F2/F3/Lecture room/Seminar room
Business Management	No
Faculty of Education	No
Environmental Health & Social Development Professions	N/A
Intermediate Phase	in thepast yest but wit consisten use of door numbers this has decreased

ICT	No
Physical Planning - Technical Services	Building 35
Academic Administration	Sometime sstill use old Missionvale venue numbers to clarify for students
MECHATRONICS	NO
Information Technology	Yes N1 and N2. But we are trying to use the venues as known by the new system.
Chemistry	We are happy with the names and numbers we have always had on North Campus at the moment. Trying to renumber or name North Campus venues accroding to some system used on South Campus is just such a waste and will just be confusing.
Enviro Health & Soc Dev Professions	-1 - Lower Ground as it confuses students
Mathematics and Applied Mathematics	the lower ground venues : -01 is still easier to note as LG as the - is often not seen [especially with exam timetable]

3.18 Do you have another name for :

- *** Class groups (A)**
- *** Group Types (Tutorial, Practical, Class)**
- *** Offering Types (01, A1)**
- *** Block codes**
- *** Any combination of these…**

Dept	* Class groups (A)	* Group Types (Tutorial, Practical, Class)	* Offering TypeS (01, A1)	* Block codes	* Any combination of the above...
Applied Accounting	No	No	No	No	No
Applied Language Studies	No	No	no	no	no
studio arts	No	No	no	no	no
Bldg & QS	-	-	-	-	-
civil	No	only class, we do not schedule each seperately, but as the need arises	no	no	no
Electrical Eng	No	No	No	No	No
Nursing Scince	BLOCK	REMEDIAL	TEACHING VENUE	NO	NO
Journalism, Media and	I don't know	Practical not practicle	I do not know	I do not know	No

Philosophy	what that is		what that is	what that is	
Physics	No	No	N/A	12	("Take your pick" ?)
Business Management	No	No	No	NO - I stick to what is asked from me	No
Faculty of Education	No	no	no	no	no
Environmental Health & Social Development Professions	NO	NO	NO	NO	NO
Intermediate Phase	sometimes year group	no	no	no	no
ICT	No	Mo	No	No	Mo
Physical Planning - Technical Services	n/a	n/a	modules	n/a	n/a
Academic Administration	No	No	No	No	No
MECHATRONICS	NO	NO	FULL TIME, PART TIME	NO	NO
Information Technology	No	No	No	Dont know what is a block code.	No
Chemistry	Yes, we use the level of the group of students to name class groups, e.g. A1, A2, A3 etc. on our time tables	No	No	We don't use these	No, we don't use these
Enviro Health & Soc Dev Professions	No	No	No	No	No

Mathematics and Applied Mathematics	don't use	class = lecture	don't use	not involved with such	can't we just have contact time without the "names" and leave it to the lecturer in use of time for lecture or tut.

3.19 Do you use the module/subject codes, the module brief description, full description, or your own description?

Dept	COMMON TERMINOLOGY
Applied Accounting	Subject codes
Applied Language Studies	use subject codes and names etc
studio arts	codes and descriptions
Bldg & QS	Codes
civil	module code, & subject name
Electrical Eng	Module/subject codes
Nursing Scince	MODULE CODES
Journalism, Media and Philosophy	Module codes
Physics	Module codes + brief description
Business Management	Yes, I use all
Faculty of Education	not own
Environmental Health & Social Development Professions	Module codes
Intermediate Phase	module codes
ICT	Subject Codes
Physical Planning - Technical Services	n/a
Academic Administration	Module code
MECHATRONICS	MODULE CODE AND USUALLY THE MODULE NAME
Information Technology	We use the module/subject codes in our timetables.
Chemistry	The module Code
Enviro Health & Soc Dev Professions	Module codes
Mathematics and Applied Mathematics	often just the module code and sometimes the name : depending on circumstances.