Towards an Integrated Revenue Management and Service Delivery System for Local Authorities in South Africa

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1. Introduction

The paper will discuss the conceptual data model required for integrated revenue management and service delivery within the domain of prepayment as well as post payment metering systems.

The objective of the paper is to create an awareness of different generations of prepayment metering systems and how these address the reality of the environment in which we sell electricity as well as manage related infrastructure. The need for integrated revenue management and service delivery will briefly be re-iterated, however previous papers presented at AMEU conventions have motivated this.

Finally the paper will propose a conceptual data model that can be used to benchmark existing metering systems and assist the utility in procuring or developing future metering systems.

This paper forms part of a mini dissertation for the School of IT, University of Pretoria. The mini dissertation will cover this subject in greater detail, which was omitted from this paper.

2. Introduction to a metering system

In South Africa water and electricity is supplied to end-users by utilities. These utilities are either government owned or regulated by government bodies, and should deliver these services in accordance with national legislation.

The Municipal Systems Act, the Constitution and other forms of legislation prescribes the standard of service to be delivered as well as rights of the utility to receive payment for such services. The term service delivery will be used to refer to a utility delivering water, electricity as well as other services to end-users. Other services include the removal of sewage and household refuge and the levy of taxes to provide and maintain municipal infrastructure such as roads, public open space etc.

The term, revenue management will be used to refer to the process of collecting revenue for the services provided.

In order to manage service delivery and revenue management, the utility requires a metering system of some sort. This metering system must be a), an inventory of all points of delivery (POD), associated metering devices, addresses, tariffs and end-users and b), keep and be able to report on the transactions generated between the utility and its end-users.

The conventional method of metering resource consumption is by using a metering device that is read once per billing cycle. The tariff for the specific POD is then applied to the consumption and a bill is generated and sent to the end-user for payment. This is referred to as a post-payment metering system.

In the South African environment there is also a very large component of prepayment metering devices. The principle here is that the end-user has a resource-dispensing device rather than a conventional meter installed at the POD, and needs to first pay the utility in order to obtain credit on the metering device.

The advantage of prepayment over post-payment metering systems is an improved cash flow for the utility as well as negating the need for meter reading and credit control actions for non-payment. The disadvantage however is that the prepayment metering device requires more intense meter management as well as purchase pattern analysis in order to identify possible cases of tampering.

In the South African environment both post- and prepayment metering devices are used and metering systems must be capable of facilitating both types. This is often achieved by integrating existing billing systems with the prepayment metering systems. The level of integration varies, however the aim is always to at least achieve integrated management information reporting.

3. The reality of our metering environment

In South Africa the metering environment refers to metered points of service delivery, with the services delivered mainly consisting of electricity and water that are used as resources.

Section 2 provided an introduction to utilities in South Africa and how they measure the resources consumed by consumers. In the ideal world the concept of a metered resource makes perfect sense and billing the client for consumed resources seems elementary. However, should the client not pay the bill or tamper with the installation at the resource consuming location one would expect that credit control policies and procedures will solve the problem. For a resource such as airtime on a cell phone, one expects to be simply cut off from the network if payment has not been made. In the case of water and electricity, the situation is somewhat more complex.

3.1 Reality of the South African metering environment: Macro-level

In order to understand the reality of the South African metering environment, it is necessary to look at aspects that affect the metering environment on a macro-, meso- and micro level.
The **delivery of basic water and electricity services is politically driven** in South Africa and every South African is considered to have a right to basic access of these resources.

Gaunt [15] explained how this, more complex situation regarding service delivery came about for electricity and it can be applied for water as well. According to Gaunt electricity started off as being a resource driven by industry, i.e. industry had the economic need to have access to electricity.

With time the need became expanded to business in general and it became a necessity to have access to electricity in order to function efficiently as a business.

Access to electricity then became a socio-economic driven resource where private legal entities wanted to have access to electricity to better their lifestyle.

Ultimately electricity became a political driven resource where it was seen as a basic service that every legal entity in South Africa is entitled to. The fact that certain legal entities cannot afford electricity lead to the Electricity Basic Support Services Tariff (EBSST) which imply that households that cannot afford access to electricity will receive a certain amount of free electricity per month.

The fact that electricity (and water) became a politically driven resource implies that credit control procedures are not as simple as denying access to the service in the case of non-payment.

The problem of non-payment was then addressed in 1990 by the introduction of the one-way prepayment meter. It was believed that if the consumer will buy electricity upfront and that an electricity-dispensing device will then dispense the resource only when credit is available on the device.

These devices were installed in great numbers and ESKOM alone has installed over 2.9million of these one-way prepayment meters in South Africa to date. The reality that struck the metering industry was that this technology alone was not the answer to non-payment of services, as meter installations were tampered with to get unmetered access to the distribution network.

The issue of non-payment required a management intervention rather than a technology intervention. Today one will find that well managed metering systems have management procedures in place that monitor the purchase patterns of one-way prepayment meters in order to detect possible cases of tamper. This is followed up by field inspections to determine why a particular point of delivery is not purchasing electricity according to its historic purchase pattern.

If one would then look at conventional and one-way prepayment meters, one would find that there are two primary aspects to these meter installations that need to be managed. In both conventional and one-way prepayment meter installations one needs to manage the revenue derived from the installation as well as the delivery of the actual service.

3.2 Reality of the South African metering environment: Meso-level

South African utilities are currently undergoing a restructuring process, which is prescribed by the Municipal systems Act (2000). There are many debates on this subject that will not be discussed here.

The effect, however, is that restructuring has had an impact on the delivery of services that is significant to metering systems in utilities. The lack of proper knowledge management and skills transfer has led to the **loss of expertise** of people who are no longer in the service of utilities. This has left a void in the people domain of our system that is still in the process of being improved. Unfortunately the wheel of service delivery cannot be stopped to accommodate these changes and it is feared that integrity of metering system data may suffer from this.

The introduction of prepayment meters in 1990 has introduced with it prepayment vending systems. The existing billing systems of utilities were not equipped to vend prepayment tokens and stand-alone vending systems entered the metering system. The entire meter configuration database is most of the time totally separate from the billing system. This **segregation of revenue systems** introduced a challenge to utilities when it came to revenue management and service delivery.

Billing systems in South African utilities are also not equipped to address the need for service delivery. A billing system is typically account driven and aims to generate a bill that can be delivered to a legal entity responsible for paying it. One would find that in most cases a legal entity’s postal address is properly captured on billing systems, but that the physical address of the point of delivery is absent or not adequate for service delivery.

In order to deliver an effective service one needs to be able to locate the point of delivery for various reasons such as meter reading, installation inspection, maintenance etc. One would find that in most utilities the revenue management of a metering system is administered by the treasury department and service delivery by the engineering department and that **communication or data flow** between the two departments is not what it should or can be.

The billing system is also procured and managed by the treasury department and has little to offer the engineering department in terms of meter management and other service delivery functionality. The engineering department may try and fill this void with an array of meter management systems that range from ‘Oom Piet and his bakkie’ addressing random maintenance calls to more sophisticated metering systems that integrate with billing systems.

One may ask if Enterprise Resource Planning (ERP) systems will not bridge this gap. However, on the one hand, the reality is that only a select few utilities in South Africa can afford the luxury of such systems. On the other hand, these systems may lack the required functionality.

In addition to the problem of fragmented systems there is also a **lack of data warehousing** on metering systems. This is necessary to not only benchmark the integrity of the data, but also to produce good quality information to management that should influence decision-making.

3.3 Reality of the South African metering environment: Micro-level

In South Africa there is wide variety of points of distribution in the water and electricity distribution networks. These range from very large consumers that require specialised metering devices to measure consumption and demand to informal housing in rural areas.

The challenges posed by our metering environment on the micro-level relates to the **variations of addressing systems** used for meter installations. One may find that the conventional street address will get you to a formalised part of a city or town, but that the same addressing specification is totally inadequate in informal housing areas and rural areas such as farms.

Brand [give reference] has identified five different addressing specifications pertaining to a point of delivery (POD) or resource consuming locations (RCL).

- The **Surveyor General's (SG) number** for a registered parcel of land, also called a cadastre. The definition of this number does not necessarily point to a single polygon in South Africa. However in most cases it will be sufficient to locate an RCL in a formal residential development.
- The **'city planner's' reference number**. This is in effect a portion of the SG number and is referred to as the stand, plot or erf number. The reason why this is significant is because the treasury department will most of the time try and keep an accurate record of this number. The SG number is 21 digits long and cumbersome to work with whereas the stand number is only 5 digits long. Together with the stand number there is also a sub division number that is used to identify farm portions. Because this number is not unique one also needs to specify the area in which the RCL is in order to locate it.
- **Street reference system**. This refers to the conventional street name and number system that will lead one to an RCL in formal areas. For central business districts it is necessary to include building name and unit number as well in order to get to a specific RCL.
- **Coordinate reference system.** In rural areas as well as informal developments, stand numbers and street addresses are frequently unavailable or differ from official records. In these areas it may be necessary to locate a RCL by its global coordinate and a global positioning system (GPS) is used to record and navigate to a RCL.
- The **POD addressing system** is an addition to that of the RCL. Consider a farm where the entrance to the farm is two kilometres away from the actual meter installation. The address reference for the farm or RCL is inadequate to locate the POD. In these cases a POD address note is added to the RCL address that may lead one *"past the main house 2km down to the pump at the river*" where the POD is situated. It may also be a GPS coordinate that pinpoints the position of the POD.

From the above it is clear that the variety of addressing systems have to be catered for in the service delivery domain. Operators of billing systems are not equipped to capture such data at the point of application for a service and without proper work flow management the installation contractor will not pass the correct addressing data back to the billing system for capture – that is if the billing system is equipped to accept 'out of the ordinary' addressing references.

4. The data elements required for a conceptual data model

In order to understand what data elements are required one needs to consider the metering environment in which the South African utility delivers a service.

Consider a traditional residential supply area. Note how street blocks, cadastre (a registered land parcel) and houses are visible. In areas such as these the street addressing reference system is typically used to locate the RCL and POD. In this example the houses are referred to as an RCL.

It is also important to note that for this supply area there will normally be a one to one relationship between cadastre, RCL and POD of a certain type such as water or electricity. In other words if one would try to locate the electricity meter for example, it would be possible to only give the cadastre as reference and there would be no ambiguity as to where the RCL or the POD would be. Should there have been more that one RCL or house on a single cadastre, this would not be possible – one would then need to specify which RCL was being referenced.

Consider a typical informal housing development. In South Africa there are many of these housing developments and although every effort has been made to ensure that each house or RCL is situated on a single cadastre with proper street names and numbers in place, this has simply not happen as planned. The reality of these housing developments is that stand numbers are used as 'house numbers' and that street names are different to official records. If street names exist they are also not well signposted and hence the street reference system does not work for these developments.

In these areas, it is more feasible to use the 'city planner's' reference system, i.e. stand number and area.

In some informal housing developments, the procedure of subdividing the cadastre or land parcel on which the houses are situated has been skipped. In this case one would find that the relationship of cadastre to RCL is one to many. It is then also impossible to use the 'city planner's' reference system since all RCL's are situated on the same stand. It would be more feasible to use the GPS coordinate reference system in these areas.

Consider a typical business district supply area. In a business district one typically finds a single cadastre with one or more buildings build on it. In these buildings there are several RCL's each with their own POD in the case of electricity. For water the utilities normally take a more sane approach of having a single water POD for each cadastre. This is a policy decision that probably evolved out of practical supply considerations. The fact is that this policy saves the utilities from endless problems regarding the configuration data, meter reading, billing and revenue collection.

The business district has the tendency to change as businesses close down and new ones take their place – shops are divided and consolidated according to the need of the tenant and the electricity POD's normally change with them. A good policy would be to install a POD for the building and let the landlord sort out sub accounting in conjunction with rent. Although further discussion on this proposal falls beyond the scope of this paper it would also make an interesting research topic: to determine how much operational cost is being spent by utilities in order to accommodate these frequent changes as well as to indirectly administer the electricity accounts of buildings on behalf of landlords.

In a business district one would also find a many to one relationship between cadastre and RCL. The fact that building names exist and that different units have numbers allows one to use the street addressing system as long as the building name and unit number are also specified.

Consider a typical rural supply area where the RCL and POD are normally situated on a farm. There might be more than one RCL on a farm and thus a many to one relationship exists between cadastre and RCL.

For a farm area it not always possible to specify the road name and there are no road (or street) numbers. Thus the street addressing system will not suffice for RCL's that are situated on farms. There are two options: either use the cadastre reference system or use the coordinate reference system.

If one looks at the size of the farm and cadastre then it makes sense to address the POD separately from the RCL in this case. Consider the POD that is situated at the dairy on the farm, but the house or RCL is quite some distance away from it. If one were to use the coordinate reference system for the RCL then the coordinate should indicate the point of entry to the RCL and a second coordinate should be used to indicate the POD.

Let us now consider which data elements would be required to manage revenue as well as service delivery in these environments.

As already mentioned in previous sections, one would require the following data elements:

⇒ POD or point of delivery
⇒ RCL or resource consuming location
⇒ Cadastre or registered land parcel
⇒ Legal entity
⇒ Agreement
⇒ Tariff

In addition to the above one would also need to be able to identify what happens to a metering device when it is not installed at an RCL. If these metering devices are merely removed and not managed they are bound to get lost. The concept of a location for a meter is necessary and the policy that accompanies it would require that a meter always has a location.

The meter arrives at the utility from the supplier and if faulty can be sent back and forth. From the utility store the meter is issued to an installation contractor who installs the meter at an RCL. Hopefully the meter stays at this location for most of its lifespan. However, if necessary, a maintenance contractor is authorized to remove it from its location and return it to the utility store. If the meter is found to be destroyed or broken beyond repair it should be legally disposed of and moved to the disposal location.

The above basic data model allows for efficient meter life cycle tracking. Note that all locations can be specified as such in the data model and that each location will have an associated legal entity that is responsible for the meters. This also allows the engineer to effectively track the meter and ultimately constitutes the basis for service delivery.

5. The proposed conceptual data model

The previous section explained what data elements should be present in the conceptual data model. It is now necessary to show the relationships that should exist between these.

Figure 1 shows the proposed conceptual data model for integrated revenue management and service delivery.

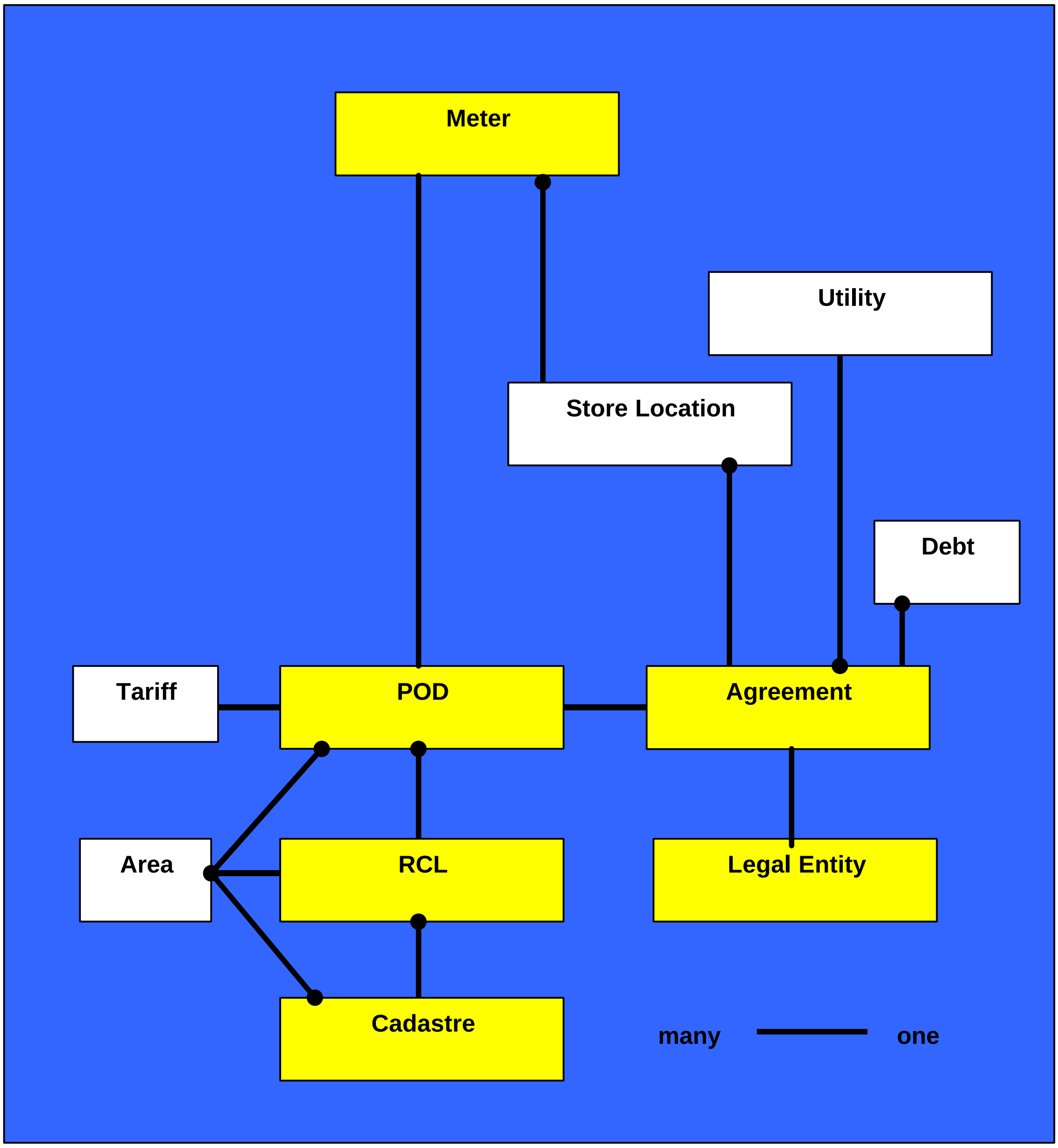

Figure 1: Conceptual data model for integrated revenue management and service delivery

In the proposed conceptual data model there are a few new data elements that are secondary to the cadastre, RCL, POD, Meter, Agreement and Legal Entity (called the ‘primary elements’ and indicated in yellow). These are Tariff, Debt, Store Location, Utility and Area.

The secondary elements are there to complete the model in terms of revenue management and service delivery.

Section 6 will show how the model can be applied to accommodate the reality of the South African metering systems. The model can live within a single metering system or can be the collection of data that is situated in various systems – as long as the relationships shown exist.

At this point it is important to consider that the above model exists to some degree in most billing and vending systems. The problem however is that some of the data elements and their attributes are contained in a single table that requires some normalisation in order to have the relationships as indicated.

Take for instance the concepts of a meter, POD and RCL. It is very easy to house these elements within the same table. That will however imply that a one to one relationship only can exist between these elements. In the next section the concept of data normalisation will be touched on and the development of the data model will also be discussed in this context.

This paper has a certain bias to prepayment metering systems and the different generations of these systems (also called prepayment resource vending systems) will be discussed in order to give the reader a better understanding how these systems evolved. The reason for being biased to the prepayment metering systems is simple: Prepayment metering devices entered the market more or less ten years ago and brought with them the segregation of vending systems from utility billing systems. It is in this domain particularly where integration is considered a necessity rather than a luxury (Brand [9]).

6. Applying the data model

The conceptual data model as depicted in figure 1 can be applied as a foundation for the integration of revenue management and service delivery. The model does not intend to be prescriptive in that all integrated systems should have the same data structure. It rather serves as an example of a model that will be able to cater for modelling the reality of the metering environment and enable decision makers to view information holistically.

The level of integration may vary. At a very basic level of integration a utility might decide to keep existing systems in place and only integrate at a data warehouse level. What would be important in this case is to consider the data captured on various systems and how this could be linked on a central data warehouse. The warehouse then serves to provide a holistic view of the metering environment modelled by the entire collection of systems. Decision-making will be based on the warehoused data.

On the other hand a utility might decide to procure or develop a metering system that caters for service delivery and revenue management on a single platform. ERP systems endeavour to achieve this. The advantage of this approach is that the operational data is situated on a single platform and data validation can take place at the time when operators enter such data. If this type of system is developed properly the operational data can be very good and would probably require little ‘cleaning’ for warehousing. The disadvantage of this approach is that older systems are becoming redundant and people need to be trained according to the new system. This results into a costly exercise that many of the smaller utilities might not be able to afford.

Between the above two extremes of integration there exists also an intermediate approach where existing systems are not replaced entirely, but rather integrated and adopted to fulfil the same objectives as the conceptual data model from figure 1. There are examples of such endeavours available in the South African market. The advantage of this approach is that existing systems are largely retained and little training is required. The disadvantage of this approach is that the owners of different systems may not be willing to integrate and that the responsibility for the overall success does not reside with a single service provider. If one would consider this route for integration it would be to the utility’s advantage to appoint one service provider to take responsibility for the integration process. This way one could reduce the burden of managing the integration process.

The result of integration of service delivery and revenue management can hold many advantages for the utility. The most important aspect of integration however is to be able to make decisions that can positively influences the delivery of services to the community. In order to deliver a better service the utility need to be able to fund new projects and maintenance to existing infrastructure. It is difficult to say what is the most important ingredient for success - is it the quality of service delivery that motivates people to pay their bills on time or is it the revenue protection processes that ensure that the utility has a steady stream of income?

This question leaves us with a ‘chicken and egg’ situation, however what is sure is the fact that to measure is to know and if you know what is really going on you have a better chance of making the important decisions that can positively influence the overall health of the metering system.

7. References

References for this document:

[1] Brand, W. *The impact of restructuring on the stability, revenue performance and price of the overall South African metering system*. Paper at the 57th AMEU Convention, October 2001. Source from Internet, www.ameu.co.za, 20 July 2002.

[2] Van den Berg, K. *Standardisation and functionality of vending systems for the electricity distribution industry*. Paper at the Vending Options 2001 conference, 2001. Source from Internet, www.esi.co.za/vending/, 20 July 2002.

[3] Wheeler, N. *Profits are from heaven, customers are from hell!* Paper at the SARPA Conference, July 2002. Source from Internet www.sarpa.co.za, 29 July 2002.

[4] STS Association, *Standard Transfer Specification*. Source from Internet, www.sts.org.za, 20 July 2002.

[5] Louw, D. *The Municipal Systems Act, Integrated Development Planning and the development of electricity within local government.* Paper at the 57th AMEU Convention, October 2001. Source from Internet www.ameu.co.za, 20 July 2002.

[6] Myburgh, A.J.B. *The concept of Situational Systems Engineering as introduced in course material.* Course material for MIT 861, School of Information Technology, University of Pretoria. 1st Semester 2002.

[7] Schonberger, R.J. 1985. *Operations management.* 2nd ed. Business Publications IVC, Texas

[8] Sage, A.P., Rouse, W.B. (Editors) 1999. *Handbook of Systems Engineering and Management.* John Wiley & Sons.

[9] Brand, W. *Interviews during 2001 and 2002 on the subject of prepayment and other metering systems, revenue management and service delivery in local government.* Mr Brand is an independent consulting engineer in systems engineering and operational management. Speaker at Vending Options Conference March 2000, Metering Europe September 2000, Sub-Saharan Power Conference 2001 and 57th AMEU Convention October 2001.

[10] SARPA Publications: SARPA Conferences, Case Studies. Source from Internet www.sarpa.co.za, 20 July 2002.

[11] ESI Magazine contains various popular articles on the subject of metering systems. These articles only serve to indicate market trends with regards to the developments in the metering arena in South Africa. Source from Internet www.esi.co.za, 20 July 2002.

[12] Carlock, P.G., Fenton, R.E. *System of Systems Enterprise Systems Engineering for Information-intensive Organisations.* The Journal of The International Council of Systems Engineering, Volume 4, Number 4 2001. pp 242-261. 2001. John Wiley & Sons.

[13] Jennings,R. 1999. *Database Developers Guide with Visual Basic 6*. SAMS.

[14] Ezzell, B. 1997. *McSd: Analyzing Requirements and Defining Solutions Architectures Study Guide.* SYBEX Inc.

[15] Gaunt. Paper delivered at SA Prepayment Week, 2003.

Other sources consulted:

Botha, MK. *Interviews during 2001 and 2002 on the subject of revenue management in the George Municipality*. Mr Botha is the acting town treasurer of George Municipality.

Department of Provincial and Local Government. Case Study: Management Support Programme, Borough of Dolphin Coast. February 2001. Source from Internet www.sarpa.co.za, 20 July 2002.

Department of Provincial and Local Government. Case Study: Management Support Programme, Brandfort TLC. January 2001. Source from Internet www.sarpa.co.za, 20 July 2002.

Department of Provincial and Local Government. Case Study: Management Support Programme, Dordrecht TLC. November 2000. Source from Internet www.sarpa.co.za, 20 July 2002.

Department of Provincial and Local Government. Case Study: Management Support Programme, Thabazimbi TLC. October 2000. Source from Internet www.sarpa.co.za, 20 July 2002.

Department of Provincial and Local Government. *Review of Powers and Functions.* Paper delivered by K. Harrison at SARPA Conference, July 2002. Source from Internet www.sarpa.co.za, 29 July 2002.

Mouton, J. 2001. *How to succeed in your Master's and Doctoral Studies*. Pretoria: Van Schaik.

Van den Berg, K. Report to AMEU executive council, 5 March 2001. Source from Internet, www.ameu.co.za, 20 July 2002.

Van den Berg, K. Management of metering systems. Paper at SARPA Conference, September 2000. Source from Internet www.sarpa.co.za, 20 July 2002.

Vernadat, F.B. 1996. *Enterprise Modelling and Integration. Principles and Applications.* 1st Ed. Chapman & Hall, London.