Cell Phone Vending
The Tshwane Case Study: The First Year

Author and Presenter: Dr Walter Smuts (Expertron Group (Pty) Ltd)
(walter@expertron.co.za)
Co-Author: Dirk Pieterse (Tshwane Metropolitan Municipality)

ABSTRACT: This paper shares experiences in rolling out a cell phone-based vending system for prepaid electricity. Some of the technologies that can be used to put together a cell phone-based vending system are presented. Operational issues and lessons learnt during the first year of managing both vendors and clients when using the system, are discussed. This includes sales statistics, system throughput, network reliability, user acceptance and the social aspects of involving people from the community in the business opportunities provided by selling electricity.

1. Introduction

Providing adequate cash payment points for prepaid electricity can be quite challenging: enough payment points must be provided to prevent long queues form forming; payment points must be close to homes; and payment points must be open beyond just the standard business hours. The demands for adequate payment points do not only come from residents, but also from government, with guidelines in terms of the minimum number of residents per payment point and the maximum distance from a house to a payment point.

These were the challenges that triggered the development of a cell phone-based vending system for prepaid electricity. Although this concept has been used for selling prepaid airtime before, there are fundamental differences between selling airtime and electricity, the most important (but not the only) being the fact that while airtime can be sold off-line, electricity sales for many types of meters must be done on-line.

This paper describes the cell phone vending system and how it operates, followed by a discussion of how the system was rolled out and used in the Tshwane Metropolitan Municipality during the past year.

2. The Vending System
2.1. System Design Objectives

The design objectives for cell phone vending included the following:

- Involve the people from the community in the business opportunities created by electricity sales.

The entry barrier for small entrepreneurs must therefore be low.

- Have no practical limit on the number of sales points that can be provided. Equipment for payment points must therefore be affordable – ideally come for free.
- Have no practical limit on where electricity is sold. The payment points must be truly mobile.
- Minimize the risk for the municipality. The payment points must belong to the vendors from the community and vendors must pay upfront for all electricity they sell.

2.2. System Description and Operation

A cell phone vending system was built to meet the design objectives. It uses standard GSM mobile telephones as affordable Point-of-Sales (POS) devices to sell and distribute prepaid electricity tokens (also called vouchers).

2.2.1. System Components

The system consists of a Vending Server with a GSM interface (e.g. GSM modem, SMPP link, GPRS via Internet) located at the offices of the municipality. Multiple servers and modems can be used to increase reliability and throughput. The Vending Server interfaces to the existing STS token generating Electricity Payment Server of the municipality. A standard PC with a Web browser is used as an administration terminal to administrate vendor accounts. The administration terminals can be located at the existing cashier counters of the municipality.

The following diagram shows the different components of the system:

Prepaid Electricity Vending Architecture
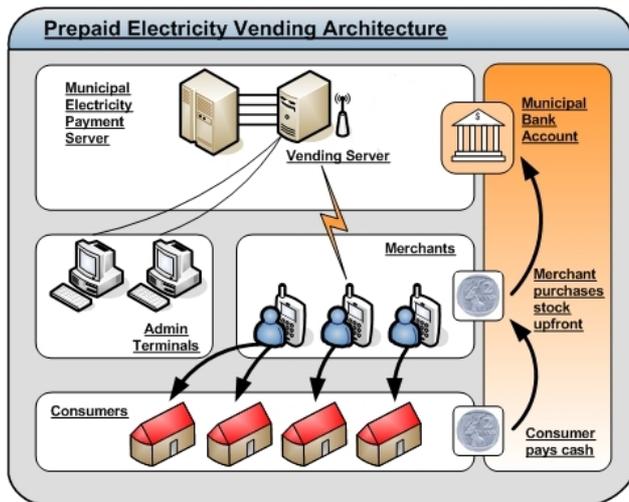
2.2.2. System Operation

The basic operation of the system consists of the following tasks:

Step 1: Register a Vendor
- The municipality identifies, signs up and trains suitable vendors. Any individual in possession of a mobile telephone and sufficient funds to purchase prepaid "electricity stock" may become a vendor.
- Vendor registration takes place at the offices of the municipality, using the administration terminal (Web browser on a PC). The vendor's cell phone is registered as a POS terminal on the Vending Server.

Step 2: Vendor buys Electricity Stock from Municipality
- The vendor purchases "electricity stock" upfront by depositing cash at the cashier counter of the Municipality. The cashier then credits the vendor's sales account, via the Web interface, for the amount of "electricity stock" paid for.
- The vendor may now sell prepaid electricity up to the amount of the vendor's sales account, and earn commission for the sales.

Step 3: Customer Buys Electricity from the Vendor
- The customer approaches the vendor to purchase electricity, and specifies the amount to be purchased (which includes any transaction fees), and serial number of the electricity meter at his home.
- The vendor compiles a GSM message on his mobile phone containing:
- A PIN (to protect his sales account),
- The electricity meter serial number of the customer,
- The amount to be purchased.
- The message is sent via the GSM service to the Vending Server.
- If the vendor's sales account has sufficient funds, the amount specified in the message is deducted from the vendor's sales account, and a response containing the 20-digit credit token is sent back to the mobile phone of the vendor. The token is obtained directly from the existing back-office vending server of the municipality.
- The vendor's sales account is then credited with the commission for the transaction.

- The vendor writes the numerical PIN in a receipt book and hands a copy, written on a business card, to the customer.
- The customer pays the vendor cash, and enters the token into his meter at home.
- If the customer has a cell phone, the token can also be SMS'ed directly to the customer's phone.

2.3. Technologies Used

The system was designed to use the following technologies:

- Terminals: Standard cell phones are used as point of sales devices. It was important to ensure that restrictions on the device did not limit the ubiquity of the solution. The total solution was implemented on the server side, without the need to roll out applications to the cell phones of vendors.
- Communication: Three GSM communication channels have been implemented:
  o SMS: Using SMS's guarantees that the solution would work on all cell phones. It is also widely accepted and needs little explanation to vendors. The cost of sending SMSs, is, however, relatively high, and the interface not very friendly.
  o USSD: The availability of USSD is a function of the network operator and not of the cell phone instruments. Its availability is in many cases not determined by technical issues, but by the network operator's ability to bill for the services. It is not as widely available in all countries as SMS, provides a simpler interface, but most probably, with no cost benefit.
  o WAP over GPRS: GPRS is by far the cheapest communication channel available, with the WAP interface also being the most user-friendly. Unfortunately it requires a GPRS- and WAP-enabled phone.

3. Tshwane Implementation

The Cell phone vending system was rolled out and used operationally in the Tshwane Metro during the past nine months. The following picture shows a customer (left), buying electricity form a vendor who sells from her home in Nellmapius (a suburb of Pretoria).

3.1. System Configuration and Integration

A dual-redundant set of Cell Phone Vending Servers were delivered to Tshwane. The dual-redundant configuration makes it possible for a secondary server to take over, should the primary server stop working.

The Cell Phone Vending solution was integrated with existing systems:

3.1.1. Existing Electricity Payment Server

Tshwane's existing Electricity Payment Sever provided a clean XML interface to add third party products. The Electricity Payment Server keeps data about and manages customers (end-users of electricity). The Cell Phone Vending Server keeps data about and manages vendors (resellers of electricity).

The existing Electricity Payment Sever includes the ability to do arrears collection (collect monthly payments for debt from customers). A two-pass transaction allows the customer to first verify the arrears amount that needs to be paid, before committing to the transaction of purchasing electricity.

Free (government subsidized) electricity tokens are "piggy-backed" on top of other transactions, but can also be requested in a separate transaction.

3.1.2. GSM Network

Tshwane opted to use only the GPRS interface (see Roll-Out Strategy) and not the SMS and USSD interfaces that were available on the system. The main driver behind this decision was the low communication cost associated with every transaction. Access to the GSM network was therefore through a VPN link over the Internet. Three GSM modems were, however, installed on each server to facilitate delivery of the tokens via SMS directly to the cell phones of those clients who wished to receive their tokens on their own cell phones.

3.1.3. Financial System

The integration with Tshwane's financial system was done in a manual way. Vendors go to one of the existing cashiers to deposit money. A standard municipal invoice is issued by the municipality. The cashier then logs into the administration interface of the Cell Phone Vending server and credits the vendor's account with the same amount. The server sends an SMS to the vendor as confirmation that his account has been credited.

The Council approved a 5% commission for vendors. Commission is *implicitly* paid out to vendors: a vendor pays in R100, after which the system allows him to sell for R105. Commission is only paid on the transaction amount, excluding VAT.

3.2. Roll-Out Strategy

Because of the difficulties (both political and social) of changing or terminating such a service, careful consideration has been given to a proper and conservative roll-out strategy. The expectation was that the system could become difficult to manage if simply thrown open for everyone to become a vendor. Because this has not been done before yet, teething problems were to be expected.

3.2.1. Pilot Tests

Field trials during 2003 in Olievenhoudtsbosch (a small settlement on the southern boundary of the municipal area) showed that the technology worked and that community acceptance would not be a stumbling block in the roll-out of the system. A single merchant was appointed to use his mobile telephone to sell electricity next to one of the Unmanned Vending Machines. Very soon, the queue of buyers moved from the machine to where the merchant was selling. Discussions with buyers indicated that they preferred buying from a person they knew, to buying from a machine.

3.2.2. Prerequisites

In order to limit the number of vendors during the first months of operation, strict prerequisites were put in place before vendors were accepted. These included:

- Being a resident within the Tshwane Metro.
- No outstanding amounts owed to the municipality.
- A R5000 first payment. This was not a deposit, but was used to buy "electricity stock". This requirement was relaxed after a few months.
- Qualify for a mobile phone contract. This requirement had two purposes: The first was to only accept vendors who had gone through another screening process. The second was to ensure that the first vendors all had identical contracts and telephones (simplifying support). After the first successful months, this requirement had been relaxed and vendors now use their exiting contracts and phones to sell electricity. (Only GPRS-enabled phones are used.)

3.2.3. Slow Growth

The rate of accepting new vendors was intentionally kept low. This allowed for time to observe and put the necessary surrounding infrastructure such as a help-desk, in place. This strategy has been proven a good choice.

3.3. Results

3.3.1. Job Creation

In spite of the fact that vendor numbers have been controlled, by the end of July 2006, about 120 new jobs had been created in the community. In reality, these were not simply jobs, but small independent businesses. Some of the entrepreneurs even employed others to help them sell, thus increasing the number of people benefiting from the system.

3.3.2. Service Delivery

There was not a notable increase in the total number of transactions per month, after starting to use the Cell Phone Vending system. Figures point to a shift in buying patterns from the Unmanned Vending Machines to the Cell Phone Vendors. The following graph shows the monthly turnover of the transactions that were done through Cell Phone Vendors. There was a steady increase from a humble start in July 2005. December 2005 saw a steep increase, due to higher spending patterns during Christmas as well as the fact that cashier payment points were closed during public holidays.

Monthly Turnover (Million Rand)
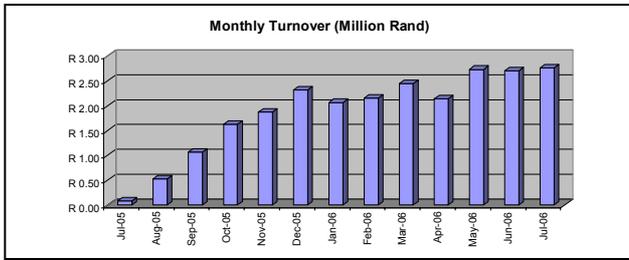
The cashier payment points were open from 07h45 to 15h15 during week days (and on the last Saturday morning of the month). The Cell Phone buying patterns show that there is a need for payment points to be open during weekends as well (between 1000 and 1500 transactions on Sundays), and that the peak purchasing times are between 09h00 and 10h00 and again between 15h00 and 17h00. These patterns match those seen for the Unmanned Vending Machines.

The following two graphs show the number of Cell Phone transactions per day as well as how these transactions are distributed, on average, during the day. Both these graphs have been taken from data for March 2006.

Number of Transactions per Day March 2006

Total Transactions per hour for March 2006
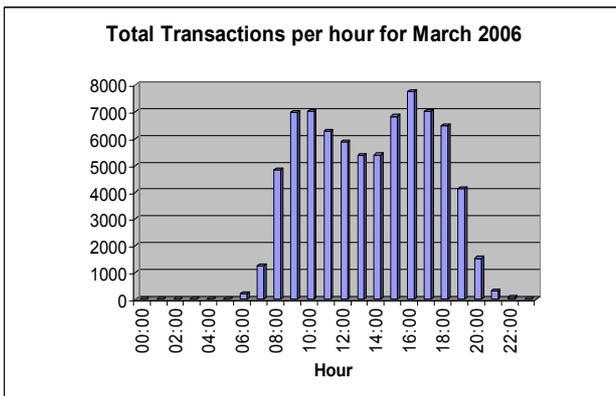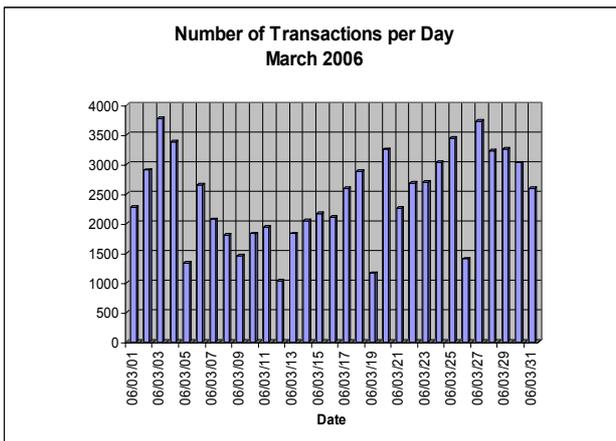
3.3.3. Customer Satisfaction
Although no formal feedback was gathered from customers, the number of transactions being done through the Cell Phone vendors point to a certain level of satisfaction. Although it is not perceived that Cell Phone Vending would replace vending through Unmanned Vending Machines, the fact that more than 30% of the transactions that used to go through those machines, are now done through cell phones,

points to a niche in the market for a cell phone based solution.

3.3.4. Vendor Satisfaction
There seems to be a wide range of vendors using the system. From those who try it out as a "hobby" to those who have resigned from permanent jobs to run a business selling electricity. The top 10 vendors for March 2006 all had a turnover of more than R73 000 for the month, with the top vendor selling just short of R120 000 for the month.

A single vendor, with about R5 000 savings and a cell phone, can run a business with a turnover of just less than R1.5 Million per year and a profit of about R75 000. To be able to do this, the R5 000 must be cycled through the system every day – which is indeed what some of the vendors manage to do.

3.3.5. Statistics
The following table summarizes some interesting statistics for the first operational year:

Parameter	Value
Total number of active consumers	110 000
Total value of sales since launch (1 July 2005 to 31 July 2006)	R24 649 891.80
Total number of vendors on 31 July 2006	120
Total sales for July 2006	R 2 762 894.00
Total number of Transactions for July 2006	82 834
Turnover for top vendor during July 2006	R 135 229.80
Average transaction size for July 2006	R 30.00

3.3.6. Problems Experienced
The first few months were not without problems. The following points are noteworthy:
- Database Speed
  Transaction rates were about 10 times what were originally expected and some database optimization had to be done to ensure that the required transaction rate could be handled.
- VAT Issues
  Tshwane paid commission on the VAT exclusive transaction value. Since only the VAT inclusive values are visible to vendors, this created some confusion in terms of the commission values.
- Double Redemption of Municipal Invoices
  Some vendors paid money into the municipal account and then tried to increase the funds in their Cell Phone Vending account by offering the invoice more than once (typically at different municipal offices). This was put an end to by a procedure of formally canceling invoices when redeemed.

3.3.7. Problems not Experienced
Some problems were anticipated, but never experienced:
- Imposters
  There were fears of unscrupulous persons pretending to be legitimate vendors and taking customer's money in a fraudulent way. None of

this behaviour has been reported by customers. It seems that there is a strong social structure within a community and that business is done within trust relationships.

- GSM Coverage
  There was a single incident of bad GPRS coverage. This was reported to the GSM operator and fixed within days.
- Transaction Speed
  It was uncertain whether all the latencies through the GSM communication channel, networks and access to databases would still result in acceptable time to complete a transaction. This was completely unfounded. Apart from the optimization required in the database, transactions seem to flow fast enough.
- Vendors Writing down Tokens Incorrectly
  Incorrect recording of tokens does happen but only infrequently. The system includes a mechanism to request a reprint of a previous token. This problem has turned out to be a non-issue.
- Vendors Charging an Extra Transaction Fee
  There were fears that vendors would abuse the system by charging customers more than the standard price. In the beginning, while the first few vendors effectively had a monopoly in their respective areas, there were a few incidents of vendors charging an extra R2.00 transaction fee. This soon stopped spontaneously when more vendors were signed up and competition leveled the playing field.

4. Future Development

Future extension of the system may include the following items:

- A mechanism for vendors with credit cards to top up their sales accounts remotely by doing the transaction through their cell phones.
- Payment interface to allow residents with credit cards to buy electricity for themselves. (Development has been completed and awaits council approval.)
- A mechanism for vendors to report meter problems, brought to their attention by residents, through a cell phone transaction on the system.
- Payment for other services such as rates, taxes and speed fines.
- Motivate higher commissions for the vendors to the Tshwane Council. More families start relying on the income provided by selling electricity.

5. Outsourced Operating Model

Tshwane decided to operate the Cell Phone Vending system by appointing and directly managing vendors. Some municipalities prefer an outsourced model in which the day-to-day operation of such a system is handled by a third party. Because of the low overhead in running a Cell Phone Vending business, it forms an ideal model for involving local entrepreneurs as "Super Vendors", thereby extending the job- and business- creation potential to include not only the vending, but also the business of operating the vending system -- which makes sense

if one keeps in mind that the success depends partially on knowledge of, and acceptance by the local community.

6. Conclusion

After running a Cell Phone-based Vending solution for more than 12 months, the conclusion is that although it is not necessarily a replacement for other payment points, it definitely solves a niche problem in a very eloquent way. The technology is mature and the residents ready to embrace this new way of buying electricity.

Biography

Speaker: Dirk Pieterse
Municipality: City of Tshwane Metropolitan Municipality
Dirk Pieterse is employed as a Chief Engineer, part of the Electricity Department, Energy Business. Responsibilities include the management of all Vending (Prepayment) related matters. He received a Diploma in Production Management, a Master Diploma in Management and a BSc Hons Degree (Industrial Technology and Management) from the Production Management Institute of South Africa. His local government career started in 1991 and in 1995 he was involved in the first Prepayment Metering project within the City of Akasia. He implemented the first Prepayment Vending Management System in Akasia. This evolved into developing and establishing the first online Prepayment Vending Management System with arrears payment collection capabilities.

Speaker: Dr Walter Smuts
Company: Expertron Group (Pty) Ltd
Dr Walter Smuts is the Managing Director of Expertron. He received a B.Eng and M.Eng Degrees (both in Electronic Engineering) from the University of Pretoria and a Ph.D from the University of the Witwatersrand. After gaining experience in South Africa's arms industry, he joined academia for a few years before starting Expertron, a company developing ICT solutions for the African market.

Company Background Information
Company: Expertron Group (Pty) Ltd
Expertron was founded by Walter Smuts and Gavin Ehlers, who were at the time lecturers in the Electronic Engineering Department at the University of Pretoria. Expertron is a company specializing in the development, installation and support of IT and Communication Systems. Expertron develops systems at the point where the Internet and GSM networks converge. Expertron has a strong Open Source capability and focuses on solutions specifically for the Southern African market. Expertron was the first company to join the Innovation Hub (a development that forms part of the Blue-IQ initiative of the Gauteng government) and has it offices in the Enterprise building on The Innovation Hub Campus in Pretoria. Expertron has developed systems that range from prepaid vending and vehicle tracking to bandwidth and password management.