

**IDENTIFYING NEW TECHNOLOGY TO IMPROVE
THE EFFECTIVENESS OF IST OTOKON'S
ENERGY MANAGEMENT SYSTEMS**

GERHARDUS ALBERTUS COMBRINK

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Supervisor: Mr. P. Geldenhuys

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DEDICATION

This study is dedicated to my wife, Idél, and our daughter, Ilanka – thank you for your support and encouragement.

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ABSTRACT

IST Otokon, a Pretoria based company delivering energy management systems to the industrial and utility market segments, has shown steady growth since its inception 15 years ago. However, after ailing financial results, all aspects of the business were interrogated. It was doubted whether its energy management system (EMS) offering, ecWIN, was fulfilling the needs of the industry. Therefore this study was needed to identify new technology which could improve the effectiveness of ecWIN.

After doing a thorough literature study on ecWIN, its competitors and the technologies currently utilised, the product was mapped to various technology management models. Deficiencies in the current software development environment were identified, including a lack of manpower and old software development tools.

The empirical study entailed determining the effectiveness of the product through a user survey in the form of a questionnaire. Certain problem areas (e.g. insufficient software testing and a lack of documentation on advanced features) were identified by this survey. The numerous complaints about the slowness of certain reports and lack in user-friendliness were also highlighted.

Also forming part of the literature and empirical study respectively, were the identification and evaluation of new technologies not yet utilised in the ecWIN sphere.

Taking a holistic view of all this information, recommendations were made on how to improve the effectiveness of ecWIN. This was presented in terms of three dimensions:

- Upgrade the current infrastructure over the next 12 months, mainly with new software development tools such as Centura Team Developer 2005, Crystal Reports, etc.
- Improve the cost-effectiveness of ecWIN during 2006 and 2007, typically by utilising GPRS, MMS, WiFi and BlueTooth to retrieve information from meters.
- Utilise a new business model (mainly centred on the cost-effectiveness dimension together with Linux and MySQL) which could allow the company to directly compete with other firms, even in the commercial and residential markets.

A fourth dimension, consisting of technologies that should not be considered for integration with ecWIN at this stage, was also identified (e.g. IPv6, XHTML and Visual Studio .NET).

In a world with rapidly changing technology, this study should not be a once-off process, but should be undertaken regularly to ascertain that the effectiveness of IST Otokon's EMS offering is constantly improved through the identification of new technology.

KEY TERMS

Energy Management Systems

Identify Technology

Improve Effectiveness

Software Development Environment

Technology Management

IDENTIFISERING VAN NUWE TEGNOLOGIE OM DIE DOELTREFFENDHEID VAN IST OTOKON SE ENERGIEBESTUURSTELSELS TE VERBETER

IST Otokon, 'n maatskappy in Pretoria wat energiebestuurstelsels lewer aan die industriële en munisipale marksegmente, het matige groei getoon vir die 15 jaar sedert sy totstandkoming. Nadat die onlangse finansiële resultate nie na wense was nie, is alle aspekte van die besigheid onder die vergrootglas geplaas. Daar was getwyfel of die energiebestuurstelsel-aanbieding, ecWIN, genoegsaam was om die mark se behoeftes te bevredig. Hierdie studie is daarom in die lewe geroep om nuwe tegnologie te identifiseer wat die doeltreffendheid van ecWIN kan verbeter.

Nadat 'n literatuurstudie gedoen is oor ecWIN, die kompeterende produkte en die tegnologieë wat huidiglik gebruik word, is die produk gepas op verskeie tegnologiebestuur-modelle. Tekortkominge in die huidige programmatuur-ontwikkelingsomgewing is geïdentifiseer, insluitende die tekort aan mannekrag en verouderde ontwikkelings-programmatuur.

Die empiriese studie het behels dat die doeltreffendheid van die produk bepaal word deur 'n vraelys wat aan gebruikers gestuur is. Sekere probleemareas (bv. onvoldoende programmatuur toetsing en 'n tekort aan dokumentasie aangaande gevorderde funksionaliteit) is hierdeur geïdentifiseer. Die veelvoudige klagtes oor die lae spoed van sekere verslae en die tekort aan gebruikersvriendelikheid is ook uitgelig.

Ook deel van die literatuur en empiriese studie onderskeidelik, was die indentifisering en evaluering van nuwe tegnologieë wat nie tans deel vorm van die ecWIN-sfeer nie.

Deur al die feite in oënskou te neem, is aanbevelings gemaak oor hoe om die doeltreffendheid van ecWIN te verbeter. Dit word aangebied in terme van drie dimensies:

- Opgradeer die huidige infrastruktuur gedurende die volgende 12 maande, hoofsaaklik deur gebruik te maak van nuwe programmatuur-ontwikkelingsomgewings soos Centura Team Developer 2005, Crystal Reports, ens.
- Verbeter die kostedoeltreffendheid van ecWIN gedurende 2006 en 2007, tipies deur gebruik te maak van GPRS, MMS, WiFi en Bluetooth om data van-af meters te versamel.
- Gebruik 'n nuwe besigheidsmodel (hoofsaaklik gefokus op kostedoeltreffendheid tesame met Linux en MySQL) wat die maatskappy beter kan laat meeding met ander firmas, selfs in die kommersiële en residensiële marksegmente.

'n Vierdie dimensie, bestaande uit tegnologieë wat nie oorweeg moet word vir integrasie met ecWIN nie, is ook bespreek (bv. IPv6, XHTML en Visual Studio .NET).

In 'n wêreld met tegnologie wat vinnig verander, moet hierdie studie nie eenmalig gebeur nie; dit moet gereeld herhaal word om te verseker dat die doeltreffendheid van IST Otokon se energiebesturingsstelsels deurentyd verbeter word, deur die vroegtydige identifisering van nuwe tegnologie.

SLEUTELTERME

Energiebestuurstelsel

Identifiseer Tegnologie

Programmatuur-ontwikkeingsomgewing

Tegnologiebestuur

Verbeter Doeltreffendheid

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LIST OF KEY TERMS AND ABBREVIATIONS

AMR – Automatic Meter Reading
ARP – Address Resolution Protocol
CCPF – Centralised Central Processing Facility
CSD – Cybernetic Software Development
DLL – Dynamic Link Library
DLMS – Device Language Message Specification
DSM – Demand Side Management
EMS – Energy Management System
ETSI – European Standard and Technology Institute
GPRS – General Packet Radio Service
GSM – Global System for Mobile Communications
GUI – Graphical User Interface
HTML – Hypertext Markup Language
IDE – Integrated Development Environment
ILC – Industry Life Cycle
IMAP4 – Internet Message Access Protocol
ION – Integrated Object Network
IP – Internet Protocol
IPX – Internet Protocol eXchange
IST – Integrators of System Technology
LAN – Local Area Network
MD – Maximum Demand
MDS – Microwave Digital Systems
MMS – Multimedia Messaging Service
ODBC – Open Database Connectivity
OLE – Object Link Embedding
OPC – OLE for Process Control
PDA – Personal Digital Assistant
PLC – Programmable Logic Control
PML – Power Measurement Limited
POP3 – Version 3 of the Post Office Protocol
PSTN – Public Switched Telephone Network
RDBMS – Relational Database Management System
RED – Regional Electricity Distributor
ROI – Return on Investment
RTU – Remote Terminal Unit
SCADA – Supervisory Control and Data Acquisition

SMS – Short Message Service

SMTP – Simple Mail Transfer Protocol

SQL – Structured Query Language

SWOT – Strengths, Weaknesses, Opportunities and Threats

WiFi – Wireless Fidelity

XHTML – Extensible Hypertext Markup Language

XML – Extensible Markup Language

1. NATURE AND SCOPE OF THE STUDY

1.1 INTRODUCTION

It is the intention of this study to focus on the essence of the title, i.e. **“Identifying new technology to improve the effectiveness of IST Otokon’s energy management systems.”**

As is evident from the above, the study will entail an analysis of the energy management systems (EMSs) delivered by IST Otokon and, in particular, on their effectiveness, which will be determined from the answers of current EMS users in a questionnaire.

The title also implies that a study into new technology will be undertaken, to identify whether any such technologies exist that could improve the effectiveness of the current EMS offering. From this, a strategy could then be devised for future developments of the company’s products.

1.2 PROBLEM STATEMENT

IST Otokon has always prided itself on the fact that it has provided its customers with solutions in the energy management field that fit their (i.e. the customers’) requirements. A 100% in-house developed energy management package (called ecWIN) grew from this attitude to business. Although the ecWIN software of today is fully documented, and changes and enhancements undergo thorough testing, the growth of the package was more entrepreneurial than specification driven: new features were typically only added after a customer or potential customer needed some specific functionality.

At the end of the 2002/3 financial year, IST Otokon made a loss for the first time in its 15 years’ existence. Although this was laid before the door of envisioned sales not materialising, serious questions were being asked about the future strategy of every aspect of the organisation, including its products and the technologies being employed, like:

- Do the products satisfy the needs of current and potential customers?
- How can the technologies currently being employed be used to better serve customer needs?
- What new technologies (e.g. WiFi, GPRS, etc.) and standards (e.g. DNP3) have become available to expand the product capabilities?
- Are there any substitute products available on the market?

The seeking of answers to these questions (especially the identifying of applicable technologies that can be used) led to this specific research study.

1.3 OBJECTIVES OF THE STUDY

1.3.1 PRIMARY OBJECTIVE

The main objective of this study is to identify new technologies that can improve the effectiveness of IST Otokon's EMS offering. As a result, the research methodology of this management report will primarily be to identify possible technologies fitting this criterion and then to formulate a strategy for implementing these in the future developments of the company's products.

1.3.2 SECONDARY OBJECTIVES

In order to realise the above mentioned primary objective (and for this study to be of real value to the company), the following secondary objectives need to be pursued:

- Providing a detailed overview of the current EMS offering, namely ecWIN;
- Obtaining feedback from current customers on the effectiveness of the product (e.g. usefulness, user-friendliness, fulfilment of needs, etc.) by using a questionnaire;
- Identifying technologies (communication media, standards and protocols, development environments, etc.) currently available (and available in the near future); and
- Evaluating these technologies to determine whether it can be used to enhance and/or substitute the current product offerings of IST Otokon.

1.4 SCOPE OF THE STUDY

1.4.1 FIELD OF STUDY

According to the OED (2004), the meaning of effectiveness is to "produce a desired or intended result". For the purpose of this study, an energy management system's effectiveness can be measured along three dimensions:

- Whether its functionality meets the requirements of assisting to manage energy;
- How user-friendly the system is; and
- Cost/value evaluation.

In order to use the system to its full potential, the system documentation needs to be of a high quality, and this aspect would thus be investigated as a fourth dimension.

It should be noted at this stage, that the title of this study doesn't imply that new technologies will be developed for the purpose of improving an EMS' effectiveness, but only that currently available ones will be analysed and evaluated for relevance.

Furthermore, this study will not include any index to measure the improvement in effectiveness of any EMS after employing the technologies identified; rather, only an indication will be given of the possible improvements that could be gained by doing so.

This study will also cover concepts stemming from other subject areas, e.g. electrical engineering and information management, in the discussion of certain issues. Although each of these subjects span a wide horizon by themselves, this study will be limited to the issues pertinent to the focus company (IST Otokon) and its products.

1.4.2 GEOGRAPHICAL DEMARCATIONS

Apart from Debswana Orapa Diamond Mine (in Botswana) and a pilot system in Saudi Arabia, all other current customers of IST Otokon are based in South Africa. This study will therefore mainly concentrate on the South African context. However, most of the principles discussed could also be applied in our neighbouring countries and even abroad, depending on the relevant country's technological infrastructure and energy management principles.

1.4.3 INDUSTRY DEMARCATIONS

The South African energy management industry is divided into four main categories which differ quite markedly in terms of their business model, capital resources and energy management philosophies:

- a) Industrial customers (e.g. Sasol, AngloGold, Iscor, Kumba Resources, etc.);
- b) Commercial customers (e.g. Pick 'n Pay, McDonalds, PostNet, etc.)
- c) Residential customers (e.g. home owners)
- d) Utilities (e.g. municipalities, tertiary institutions, etc.)

The research will mainly be centred on the two sectors currently of importance to IST Otokon, namely industrial customers and utilities. An investigation will also be made into the possibility of expanding into the commercial sector by employing the same (or new) technologies and products.

1.5 RESEARCH METHODOLOGY

The following approach will be used to pursue above mentioned objectives:

1.5.1 LITERATURE STUDY

In order to provide a theoretical background to the problem statement, the reader has to be informed about the focus company and its products, as well as the industry (energy management) and the field of study (technology management) respectively.

Company records will form the main source of information for the discussion of IST Otokon and its EMS offering ecWIN. The necessary information about the latter two topics (i.e. the industry and the field of study) will be obtained through an in-depth literature study, especially focusing on different technology management models relevant to this study.

From this theoretical background, the reader will have a reasonable knowledge of a typical ecWIN system and its underlying technology. New technologies that can be employed to improve the effectiveness of these systems will also be researched, mainly by using the Internet and printed publications as an information source.

1.5.2 EMPIRICAL STUDY

The literature study will be complemented with an empirical field investigation into the current effectiveness of an ecWIN system (i.e. an IST Otokon EMS). Information regarding the perception and needs of the company's customers, with regards to the company's products, will be obtained through a questionnaire.

Technology management models identified in the literature study will be applied to ecWIN, with some attention given to possible changes in the near future (regarding the industry and technology) and its influence on IST Otokon.

Some of the technologies identified in the literature study (which doesn't yet form part of an ecWIN system) will also be briefly evaluated.

1.5.3 ANALYSIS OF RESULTS

Once the empirical research has been conducted, the results obtained must be interpreted in the light of the knowledge obtained from the literature study. This will include an analysis of the questionnaire answers, as well as the results from applying the different Technology Management models and the evaluation of future technologies.

1.5.4 FORMULATING A NEW TECHNOLOGICAL STRATEGY

Through the practical application of the knowledge obtained from this research, a new technological strategy must be forged, enabling IST Otokon to improve the effectiveness of its EMSs.

1.5.5 SUMMARY OF THE RESEARCH METHODOLOGY

The research methodology can be graphically depicted as in Figure 1.

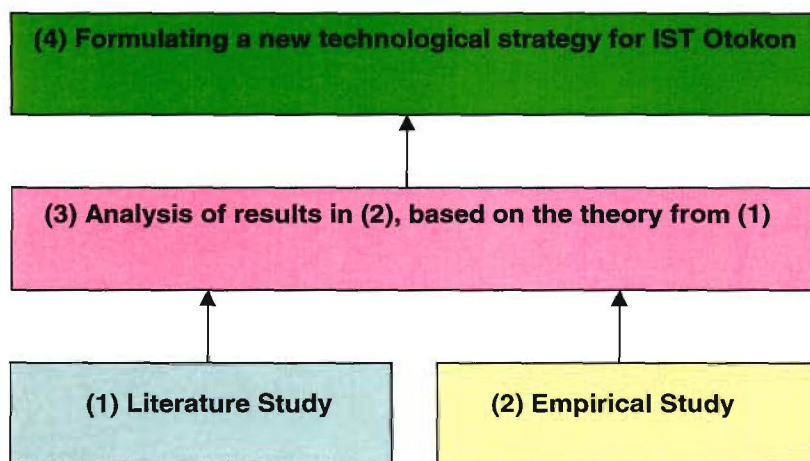


Figure 1: Research Methodology

From this figure, it is clear that the results of the empirical study will be analysed and interpreted against the literature study before a new technological strategy can be formulated. The importance of the literature study is also highlighted, since the knowledge obtained from it is needed to successfully understand this new strategy.

1.6 LAYOUT OF THE STUDY

The research methodology described in the previous section is deployed in this research document's various chapters as follows:

Chapter One (i.e. the current one) gives an insight into the study and the reasons why it was undertaken.

Chapter Two introduces *IST Otokon* (a division of IST Group) as the organisation that will be studied in this research. The industry and engineering field (i.e. *energy management*) in which the focus company operates is also discussed. Lastly the field of *technology management* is described, with a look at different theoretical models as well as applicable current and future technologies.

Chapter Three concerns itself with the collection of data from current users of *ecWIN* (IST Otokon's EMS offering). The chapter further fits the target company's products into the *different Technology Management models identified in the literature study*. Finally, most of the technologies identified in the literature study will be evaluated in the *ecWIN* environment.

Chapter Four incorporates the statistical analysis and results of the survey in the empirical research. It also includes a discussion of the results obtained by evaluating the newly identified technologies in the ecWIN environment.

Lastly, **Chapter Five** contains a newly forged technological strategy for IST Otokon to improve the effectiveness of its EMSs, divided into three different dimensions. Specific recommendations are made with regards to which technologies to utilise in the short term (2005), in the medium term (2006/2007) and which technologies to ignore for now.

1.7 SUMMARY

Now that the reader is familiar with the reasoning behind this research document and the methodology which will be followed, we can continue with the literature study.

2. LITERATURE STUDY

2.1 IST OTOKON

2.1.1 BACKGROUND INFORMATION

Otokon Systems (Pty) Ltd was founded by Attie van Jaarsveldt in 1987, to focus on the electricity usage of big industrial companies (Nell, 2003). The core business was to verify the correctness of the monthly electricity account (from Eskom), and to do internal cost allocation to the various business units within the industry. Otokon's first customer was Vaal Reefs Exploration & Mining, an Anglo American gold mine west of Johannesburg (renamed to AngloGold Vaal River a few years ago). When Otokon received a similar EMS (Energy Management System) contract from Sasol in 1994, Chris Nell joined the company as Software Development Director.

Otokon continued its steady growth, and was becoming well-known player in the energy management industry in South-Africa. IST (Integrators of System Technology) saw the potential of Otokon, and acquired the company in 1998. Otokon operated as a subdivision of IST Energy during this time until 2001, when Otokon became a full division of IST, called IST Otokon. During the same year, Otokon broadened its skills base, by employing a few experts in the energy management field.

However, some structural changes took place at the organisation in the 2002/2003 financial year. Chris Nell became the Managing Director (MD) of the division, and IST senior management decided to move IST Otokon from Potchefstroom to its main office in Pretoria. This decision was made in anticipated growth for IST Otokon during the 2002 – 2005 period. Unfortunately, envisioned sales for the 2002/3 financial year did not materialize, and the company made a loss for the first time in its history.

Although profitability was restored in the following financial period (as shown in section 2.1.2), this profit was at a reduced margin. The time has thus come for Nell and his management team to make some key decisions on the future of the company, especially in terms of the product(s) and the business model(s) that should be employed.

2.1.2 RECENT FINANCIAL FIGURES

Taking a look at the financial performance of the organisation over the past three financial periods serves as support for the discussion in the previous paragraph. The following table was compiled with the help of IST Group's Financial Department:

Year	2003/4 R/c	2003/4 %	2002/3 R/c	2002/3 %	2001/2 R/c	2001/2 %
Income	R 27,186,411	100.00%	R 12,354,851	100.00%	R 14,004,413	100.00%
Cost of Sales (COS)	R 16,776,161	61.71%	R 4,325,791	35.01%	R 5,799,911	41.41%
Gross Income	R 10,410,250	38.29%	R 8,029,060	64.99%	R 8,204,502	58.59%
Divisional Expenses	R 8,419,420	30.97%	R 8,261,951	66.87%	R 6,882,680	49.15%
IST Group Expenses	R 573,295	2.11%	R 111,696	0.90%	R 0	0.00%
Profit Before Tax (PBT)	R 1,417,535	5.21%	-R 344,587	-2.79%	R 1,321,822	9.44%

Table 1: Recent Financial Figures of IST Otokon (Brandt, 2004)

After boasting a healthy 9.22% profit on sales of R 14 million in the 2001/2 financial period, IST Otokon's results seriously slipped the following year. Envisioned sales (which involved extensive marketing efforts) just didn't materialise, and although the Cost of Sales (COS) decreased in this period to only 35%, this wasn't enough to offset the expenses and the company recorded its first loss in 15 years of existence.

As described, the operating offices were moved to Pretoria during the 2003/4 financial year. Despite the fact that this move meant an increase of approximately R 460 000 in annual expenses (because of office space and facilities utilisation), company profitability was restored in the following year. However, although the revenue was nearly twice that of the 2001/2 financial period, the profit before tax (PBT) was nearly the same and the profit margin seriously dipped to just above 5%.

2.1.3 DRIVING FORCE, MISSION AND VISION

Presented on the walls of the company hall, the driving force, mission and vision of IST Otokon can be viewed by all employees and customers. Proposals made in this study will need to be in line with these statements.

2.1.3.1 Driving Force

"The optimisation of utility usage with the company's in-house developed software product, called ecWIN." (IST Otokon, 2004b.)

2.1.3.2 Mission

"To become the preferred choice supplier of utility usage optimisation solutions to large users of energy in Southern Africa." (IST Otokon, 2004b.)

2.1.3.3 Vision

According to IST Otokon (2004b): "This mission will be achieved by:

- Providing superior management information tools;
- IST Otokon's professional energy management consultation services;
- Timeous delivery on projects;
- 99% availability of the data; and
- At least 97.5% integrity of the data."

2.1.4 WORK FORCE

2.1.4.1 Organisational Structure

IST Otokon initially grew into a typical line management structure, but after experiencing certain problems inherent to this structure (such as delays, unnecessary administration, etc.) it was decided to use a new structure. At the end of August 2004, the organisational structure of the company looked as follows:

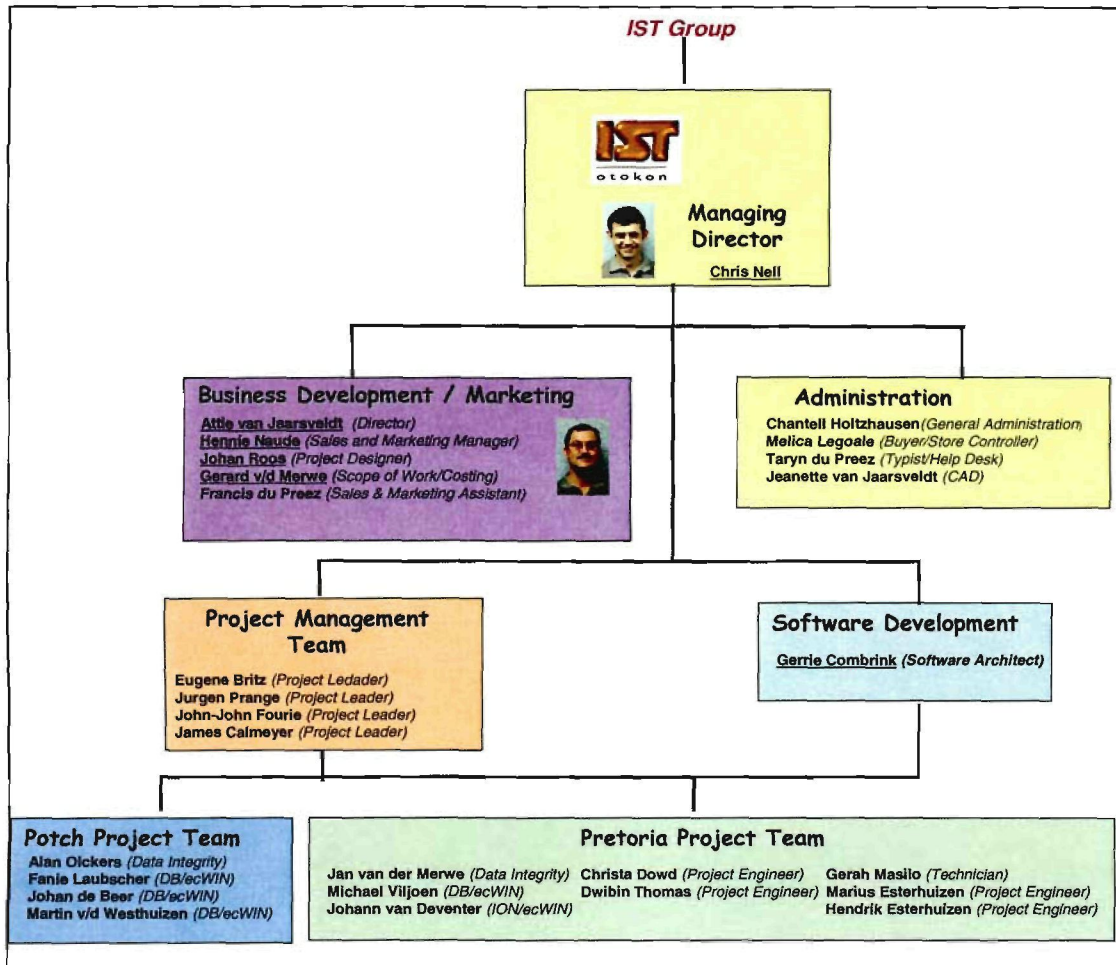


Figure 2: IST Otokon Organisational Structure (Nell, 2004)

The company currently has two directors and four managers – all of them have the authority to task the rest of the employees (horizontal authority lines). There are also vertical authority lines for purposes such as granting leave, acting as a mentor, evaluation during salary review, etc. Of this management team, only one has completed an MBA degree, while two others are in their final year of study with theirs.

This type of organisational structure is classified as a matrix structure. Smit and Cronjé (1997:223) state that the matrix organisation structure has been created to incorporate the

advantages of various organisation structures into one. This matrix organisation structure is particularly suited to ad hoc and complex projects requiring specialised skills.

2.1.4.2 Employee Qualifications

As can be expected from a company of this nature, most of the 27 employees hold some formal qualification:

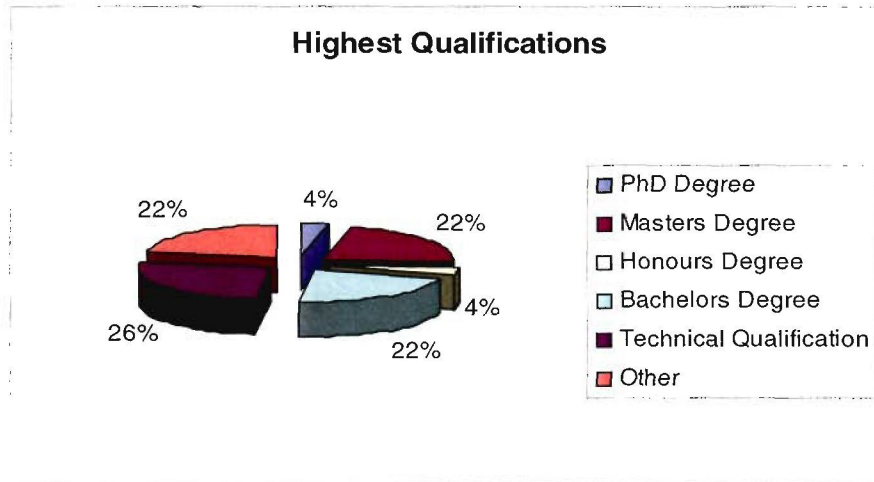


Figure 3: IST Otokon Employee Qualifications (IST Otokon, 2004b)

2.1.4.3 Employee Demographics

In line with the South African Government's Affirmative Action policy, IST Otokon has transformed over the last few years from a "pale and male" organisation, to one which is somewhat more representative of the local work force. There is, however, some room for improvement, as can be seen from the following diagram:

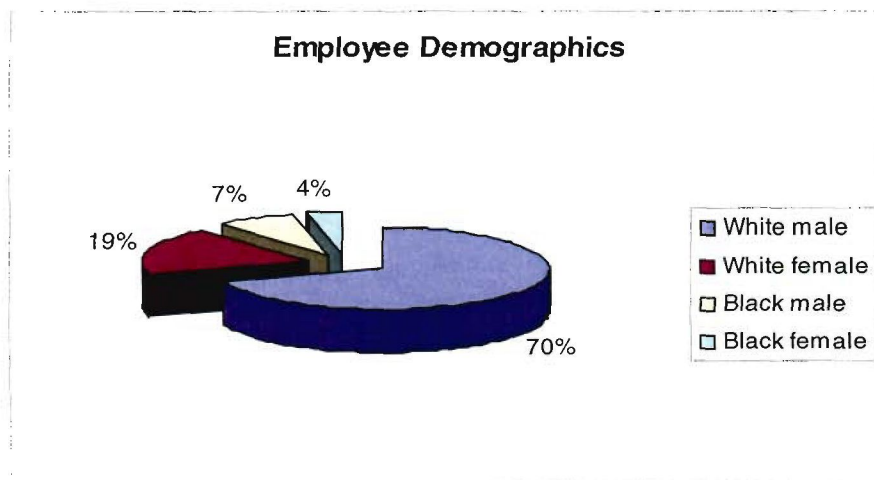


Figure 4: IST Otokon Employee Demographics (IST Otokon, 2004b)

2.1.5 CUSTOMERS

Over the last decade IST Otokon's customers grew from one gold mine (AngloGold Vaal River, formerly known as Vaal Reefs Exploration & Mining) to 36 ecWIN sites. The biggest of these include AngloGold, Sasol, Kumba Resources, bhpBilliton, Samancor, Iscor and Ticon SA as well as some tertiary institutions such as the North-West University, the University of Pretoria and esATI (Eastern Seaboard Association of Tertiary Institutions).

Furthermore, some of the big municipalities and/or metropolitan areas have also become customers, including City Power (Johannesburg), Mangaung Municipality (Bloemfontein) and Nelson Mandela Metropolitan Municipality (Port Elizabeth).

Altogether, these customers represent more than 10 000 different metering points and over 13% of the electrical energy generated by Eskom.

2.1.6 PRODUCT

IST Otokon's main product, ecWIN, helps energy consumers to manage, reduce and control energy costs by identifying and scheduling energy intensive activities, aggregating loads and helping the energy manager to allocate the energy cost per business unit or process (IST Otokon, 2004a:1).

The ecWIN Suite manages all communication with the remote and automated metering devices in the field and alerts the system manager when any problems occur. The system collects raw meter data, performs metering calculations and verification routines and stores the data in a centralised relational database with Structured Query Language (SQL) capabilities. Any commercial database platform can be used such as MS SQLServer, Centura SQLBase or Oracle Server.

With ecWIN a user can set up, display and manage a plant's energy resource information online, from anywhere in the world, using a combination of both push (e.g. alarming through SMS or e-mail) and pull (data mining through a Web browser) information technologies.

The ecWIN Suite, currently in version 5.1, consists of several modules for a complete integrated energy monitoring and energy information display solution, based on true client-server and Web-based technology. Its modular design will suit the needs of all operations, from small to very large consumers of energy. The ecWIN Suite can also be used for power quality analysis where the voltage and current parameters are measured at compliance intervals.

A typical system layout, indicating the various modules of the ecWIN Suite, is shown in the following figure. The function of each of these modules is briefly discussed afterwards.

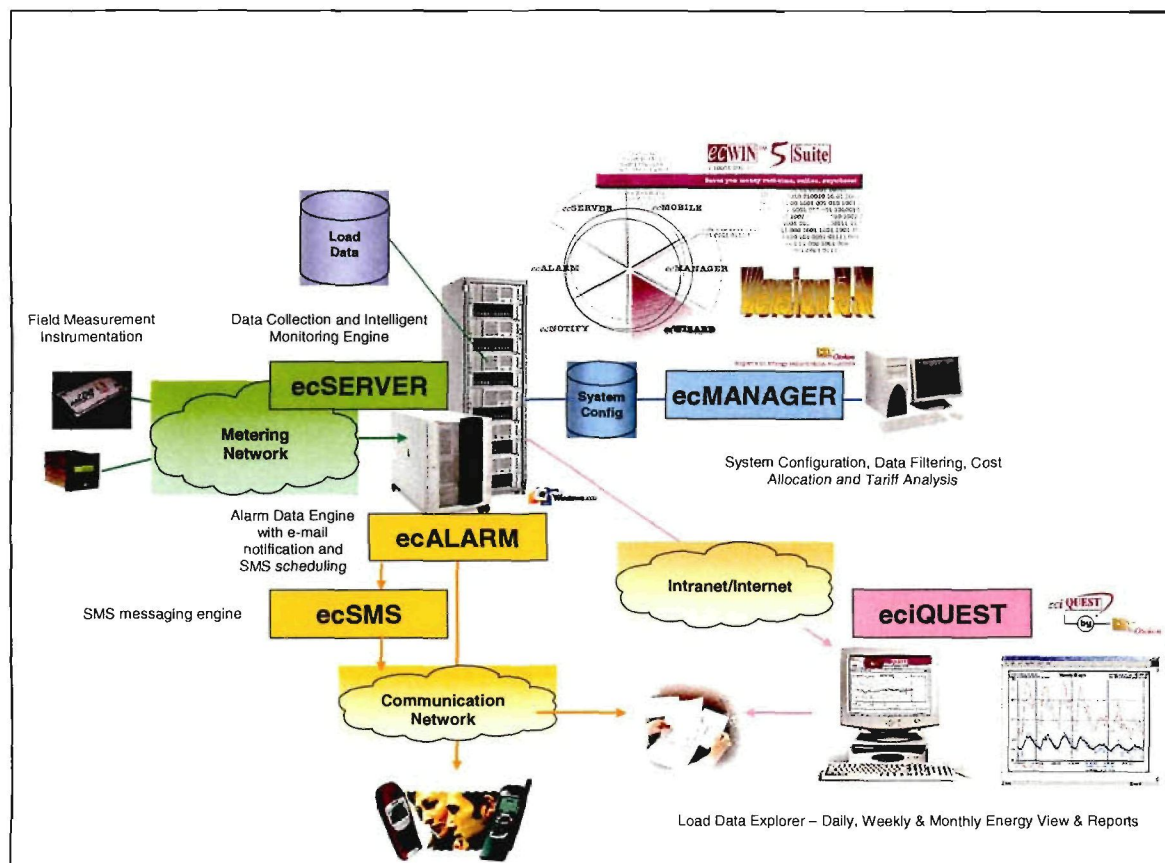


Figure 5: ecWIN 5.1 System Layout (IST Otokon, 2004a:1)

2.1.6.1 ecMANAGER

This module allows the system administrator to configure the ecWIN system, comprising a variety of entities such as data loggers, meters, channels and mathematical calculations (called groups). It also provides data diagnostics tools for verifying data integrity and manipulating the data. A very important feature of this module is the verification of electricity accounts and the re-allocation of electrical costs to different business units (IST Otokon, 2004a:26). These latter two functions are done according to the customers' electricity tariffs, as described in section 2.2.3.

2.1.6.2 ecSERVER

ecSERVER is the data collector and information driver of the ecWIN system (IST Otokon, 2004a:4). It can automatically retrieve data from standard commercially available data loggers, RTUs (Remote Terminal Units), energy meters and other file systems and store the data in the central ecWIN historian for further analysis and accounting services.

The software can collect data through serial, wireless, modem or Ethernet links, thus one can manage a single site or a global network of devices from one central point.

2.1.6.3 eciQUEST

The Web-based load data explorer tool utilised by the normal users of an ecWIN system is called eciQUEST. Data mining (such as load data profiles as well as energy consumption enquiries and reports) can be done over the company's intranet or even over the Internet using a standard Web browser, such as Microsoft Internet Explorer (IST Otokon, 2004a:68).

2.1.6.4 ecALARM

ecALARM is the alarming engine of ecWIN that automatically forwards energy information, system and data integrity information and other diagnostic data to the users based on predefined schedules and real-time system alarm and notification calls (IST Otokon, 2004a:61).

These alarm notifications can take place through either sending an e-mail or instructing ecSMS (discussed next) to send an SMS message. Both of these can be sent to either an individual or a predefined group of users.

2.1.6.5 ecSMS

Instant notification of system alarms can be achieved by utilising ecSMS, the Short Message Service (SMS) gateway of ecWIN. With this module, alarms generated by ecALARM are sent as an SMS message to an end-user's mobile phone (IST Otokon, 2004a:66).

2.1.6.6 ecCONTROL

Load control technology focuses on the control of electrical equipment (such as residential hot water heaters and air-conditioners) in an effort to manage and reduce the consumer's electricity cost. A new module developed for ecWIN to fulfil this role is ecCONTROL - it calculates the required on/off states of the load switches that it has to control.

To apply these load control signals to the load switches, the ecCONTROL module interfaces via a serial RS-232 link to an Encoder/Switch Controller, which translates and transmits the on/off signals to the physical load switches via some communication medium, typically radio communications.

2.1.6.7 Other Modules

Apart from the six main modules described above, there are also a number of small applications, which were often developed for a specific customer and/or a specific task (IST Otokon, 2004a:66). One of these, ecGCOM, is of relevance to this study and will be discussed next.

a) ecGCOM

As described earlier, ecSERVER is able to collect data directly from a PLC (by using TCP/IP). These data requests could also be sent to a small router program (ecGCOM),

which dials the specific PLC of interest and sends the data retrieval request to it (encapsulated in RS-232). In this case, both the PLC and the computer running ecGCOM have GCom GSM modems connected to their serial ports. The PLC answers with the relevant data records over the same communication channel. ecGCOM then send response from the PLC to ecSERVER and disconnects the data call.

2.1.7 COMPETING PRODUCTS

There currently exist a number of software products that can be regarded as competing products to ecWIN because of similar functionality. Each of these will be discussed briefly in this section.

2.1.7.1 DG20

This product from Germany's Landis+Gyr was the first encounter with an AMR (Automatic Meter Reading) system that many of the South African industries had, since it was used extensively by Eskom. It entailed the customer's Eskom meters being connected to a modem with a telephone line; these meters were then dialled by Eskom to read the data from which the electricity account was compiled. (However, only a limited variety of meters and modems were supported). Although the software is a MS-DOS application (which was replaced with the Windows-based DGC300 discussed next), it is still used internally by some ecWIN customers.

2.1.7.2 DGC300

The DGC300 remote meter reading (RMR) central station is a software application for reading out remote terminal units via the telephone network, leased lines or optical interface (Landis+Gyr, 2004:5). It is a follow-up to DG20 (also from Landis+Gyr), with the same functionality as its predecessor, but an easier-to-understand user interface. Previous versions only worked under Windows 95 and Windows 98, but the newest version (3.5) also supports Windows NT, Windows 2000 and Windows XP.

2.1.7.3 MV-90

Itron (an organisation in the USA) has a product MV-90, which is regarded as the industry's leading system for collecting and processing interval data from complex metering devices. In fact, it is the industry's only true multi-vendor solution (Itron, 2004). The organisation purchased the rights to use the protocol of all the major meter manufacturers in one standard package, with similar functionality than DGC300.

Furthermore, support was added for more communication devices (e.g. radio pads, GSM modems, etc.). Unfortunately, the acquisition of the protocol rights resulted in an extremely expensive software suite (even with a favourable exchange rate) that is used in South Africa by only Eskom and a few large industries, e.g. Sasol.

2.1.7.4 ION Enterprise

ION Enterprise is an energy information management solution for the operations end of a business. It offers control capabilities, comprehensive power quality and reliability analysis (Power Measurement, 2004). This successor of Pegasys (initially a SCADA system) has gained momentum in terms of functionality over the last few years. Especially the reporting side has got a lot of attention, making provision for tariffs similar to ecWIN's functionality.

Recently version 5 was released, which has a Web interface for the load profiles. This means that ION Enterprise now has essentially the same functionality as ecWIN (with the added advantage of being a SCADA), although it is much more limited in terms of the different metering devices supported.

2.1.7.5 E-MAN

Strike Technologies (a South African company) has a huge installation base for their internally developed meter, the Enermax. This platform was leveraged to introduce a lot of organisations to their own propriety software E-MAN, which converts the meter data to an easy-to-use open-data format (Strike Technologies, 2004). However, this software is still client/server based and only works with Enermax meters.

2.1.7.6 P-Maxx

Especially in the commercial sector, the South African company PMT (Power Management Technologies) has made huge in-roads on delivering energy management services to different organisations. Their customers gain access to features such as data mining and tariff analysis through PMT's Web site. Once again, the biggest drawback here is that only a limited number of metering devices are supported.

2.2 ENERGY MANAGEMENT

A complete discussion of the energy management subject field falls outside the scope of this study. However, principles needed to understand the remainder of this study, will be briefly discussed in this section.

2.2.1 FUNDAMENTALS OF ENERGY MANAGEMENT

Energy management is the act of controlling the usage of energy resources (IST Otokon, 1999:2). These energy resources include electricity, coal, diesel, gas and water. However, for the remainder of this study, only the field in which IST Otokon is involved (i.e. electrical energy management) will be discussed.

The aim of energy management should be to reduce the cost of energy. This doesn't necessary imply that energy consumption or the production of goods should be reduced, but just that the cost efficiency of consumed energy should be improved.

Energy management is not a once-off process; it has to be continually implemented by the entire organisation (IST Otokon, 1999:4). To assist in this task, an organisation can utilise an energy management system (EMS), such as IST Otokon's offering named ecWIN.

2.2.2 CATEGORIES IN THE ENERGY MANAGEMENT INDUSTRY

As explained in section 1.4.3, the South African energy management industry can be divided into four distinct categories:

- a) Industrial customers (e.g. SASOL, AngloGold, Iscor, Kumba Resources, etc.);
- b) Commercial customers (e.g. Pick 'n Pay, McDonalds, PostNet, etc.)
- c) Residential customers (e.g. home owners)
- d) Utilities (e.g. municipalities, tertiary institutions, etc.)

The first customers of IST Otokon were all in the first of these categories (i.e. industrial). Over time, some municipalities and tertiary institutions also became ecWIN users, by using similar technologies and tools as in the industrial sector. However, since financial resources are not so readily available in the commercial and especially not in the residential sectors of the industry, a different approach/business model might be needed.

2.2.3 SOUTH AFRICAN TARIFFS

When Thomas Edison switched on the first commercial lighting system in the world (September 1882 in New York), the most important question in his mind must surely have been what he should charge the customer for this revolutionary service. Today, more than a century later, energy supply utilities throughout the world face the problem of setting acceptable tariffs for services provided (IST Otokon, 1999:24).

A wide variety of tariffs exists; however, for the purposes of this study it is sufficient to state the principles of three tariffs used in South Africa:

2.2.3.1 Single Energy Rate Tariffs

With this tariff, a payment is made for consumption only at a fixed rate, i.e. the amount of energy is directly related to the amount charged (IST Otokon, 1999:32). A typical example is the electrical account of a house in a municipal area.

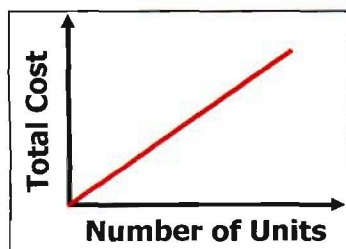


Figure 6: Single Energy Rate Tariffs (IST Otokon, 1999:32)

2.2.3.2 Demand Tariffs

This tariff consists of a demand charge and an energy rate (IST Otokon, 1999:32). Like the single energy rate tariffs described above, the energy charge is directly related to the amount of energy used. However, there is also an additional charge for that moment in the month where the consumption is at its peak, called the maximum demand (MD). A typical example of this is Eskom's Nightsave tariff.

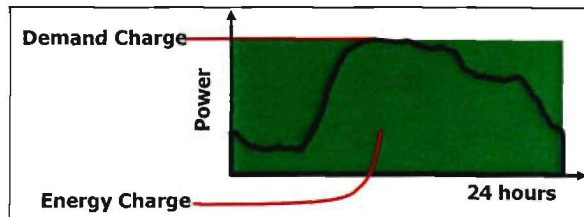


Figure 7: Demand Tariffs (IST Otokon, 1999:33)

2.2.3.3 Time-of-Use (TOU) Tariffs

Under a TOU tariff, there is still a maximum demand charge as in the demand tariffs explained above, but different rates are applied at different times (IST Otokon, 1999:32). Eskom's Megaflex tariff is a typical example of a TOU tariff.

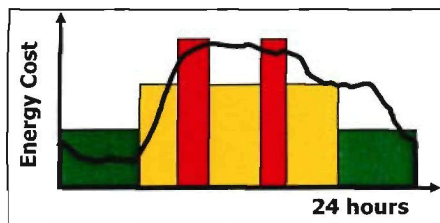


Figure 8: Time-of-Use Tariffs (IST Otokon, 1999:33)

2.2.4 DEMAND SIDE MANAGEMENT (DSM)

No discussion of energy management would be complete, without describing demand-side management (DSM), which originated in the USA during the 1970s when the energy prices started to rise sharply (IST Otokon, 1999:40). This prompted customers to reduce energy consumption. The cost of building new power stations also rose sharply and utilities wanted to avoid doing this. It (DSM) then became a joint effort between the customer and the utility to use electricity wisely.

DSM involves all actions on the demand-side (or customer-side) of the electric meter. It can be either directed towards load management (shifting from peak times to off-peak times), energy efficiency or both.

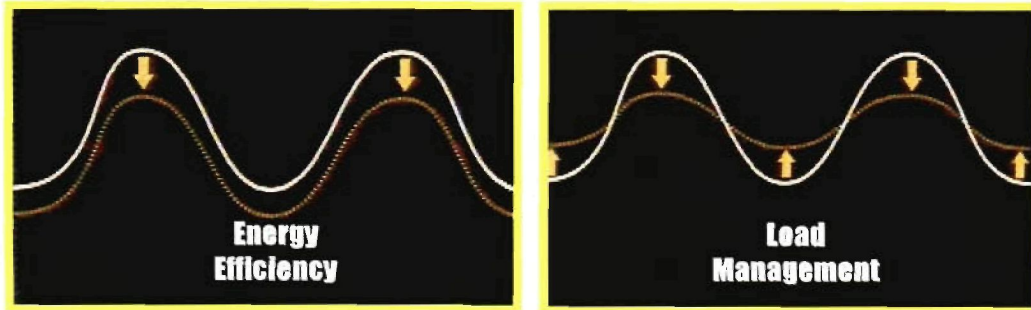


Figure 9: DSM Alternatives (IST Otokon, 1999:33)

In the South African context, Eskom DSM initiatives are viewed as “the planning and implementation of those utility activities, designed to influence the customer to use electricity in ways that will produce desired changes in the utility’s load shape” (Eskom, 2003). The objective hereof, is “the long-term, sustainable daily Megawatt peak reduction on Eskom system load during the Weekday periods 18h00 – 20h00, in order to defer the construction of new generation capacity.

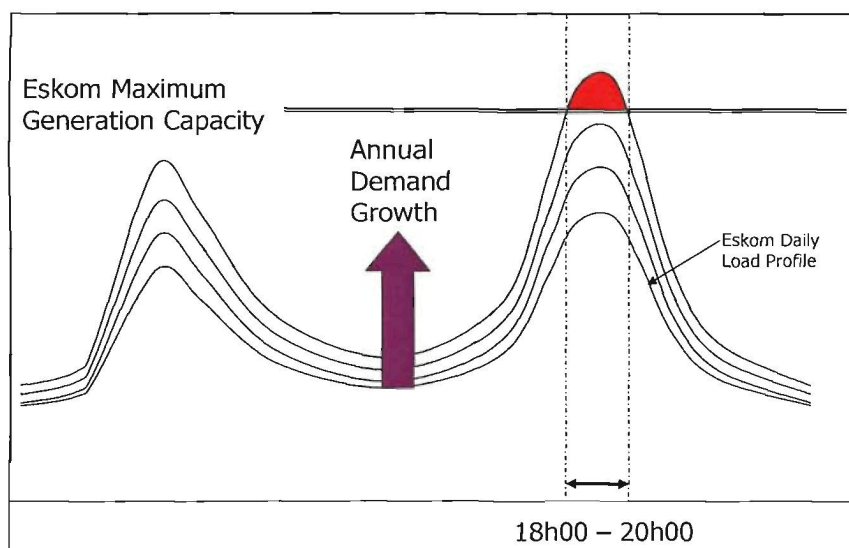


Figure 10: Eskom Maximum Generation Capacity (IST Otokon, 2004a:5)

2.3 TECHNOLOGY MANAGEMENT

The field of technology management spans a wide horizon. Part of this subject field is a variety of models, explaining and classifying the changes in technology over time. Only the models relevant to this research will be described in this section.

2.3.1 INDUSTRY LIFE CYCLE (ILC)

In Figure 11, the industry life cycle (ILC) is displayed; this is the way new technologies and products evolve over time in the market.

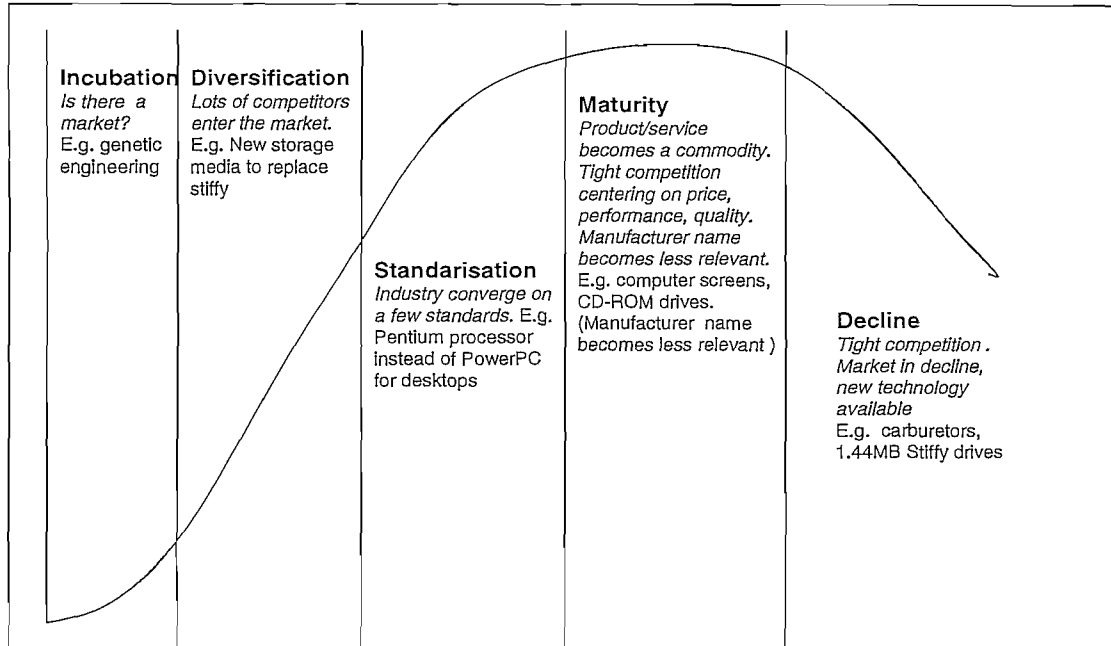


Figure 11: The Industry Life Cycle (Geldenhuys, 2003a:1)

These five phases in this cycle is compared in Table 2, in terms of their technology emphasis, market emphasis, cost emphasis, status, organisation and risk & uncertainty.

Stage	Technology emphasis	Market emphasis	Cost emphasis
<i>Incubation</i>	<ul style="list-style-type: none"> • Invention • Applied research • Radical innovation 	<ul style="list-style-type: none"> • Specialist • Very small 	Low
<i>Diversification</i>	<ul style="list-style-type: none"> • Product performance • Speed of development 	<ul style="list-style-type: none"> • Short product lives • High variety 	Low
<i>Standardisation</i>	<ul style="list-style-type: none"> • Dominant design • Fewer new designs 	<ul style="list-style-type: none"> • Rapid growth • Segmentation 	Increasing
<i>Maturity</i>	<ul style="list-style-type: none"> • Process innovation • Minor improvement 	<ul style="list-style-type: none"> • Price • Promotion • Competition 	High
<i>Decline</i>	<ul style="list-style-type: none"> • In-use life • Technological diversification 	<ul style="list-style-type: none"> • Price • Quality • Service 	Very high

Stage	High status	Organisation	Risk & uncertainty
<i>Incubation</i>	<ul style="list-style-type: none"> • R & D 	Informal	Very high
<i>Diversification</i>	<ul style="list-style-type: none"> • R & D and Marketing 	Informal	High
<i>Standardisation</i>	<ul style="list-style-type: none"> • Marketing 	Formalising	Low
<i>Maturity</i>	<ul style="list-style-type: none"> • Production • Finance 	Formal	Medium
<i>Decline</i>	<ul style="list-style-type: none"> • Production • Finance • Marketing 	Formal	High

Table 2: The Industry Life Cycle and its Implications (Geldenhuys, 2003a:4)

An important element missing from the comparison above is the question of where the power lies in the value chain, in each of these five phases of the cycle:

a) Incubation: Since performance of the technology is low during this phase, it has a high cost and the market is not established, pioneers often end up bankrupt. (This is why the leading edge is often referred to as the “bleeding edge”). The new product is most often a substitute for another product and it is uncertain where the power in the value chain lies.

b) Diversification: The innovator begins to gain power over the value chain in this phase; success is often associated with being the first to market a product with a significantly higher performance level.

c) Standardisation: With the emergence of the dominant technology and the accompanying growth in sales, the innovator has power over the value chain in this phase.

d) Maturity: When the product reaches this phase it becomes a commodity, with price being the most important factor. This fact results in the consumer gaining power over the value chain. Quality, responsiveness and flexibility are the important strategic decision for a firm with products in this phase.

e) Decline: The consumer still has control over the value chain until the emergence of a radically new technology ends this life cycle. Technological expertise, rather than market experience, appears to provide the competitive advantage in this phase.

2.3.2 TECHNOLOGY S-CURVE

Closely linked to the industry life cycle discussed above, is the technology S-curve displayed in the figure below.

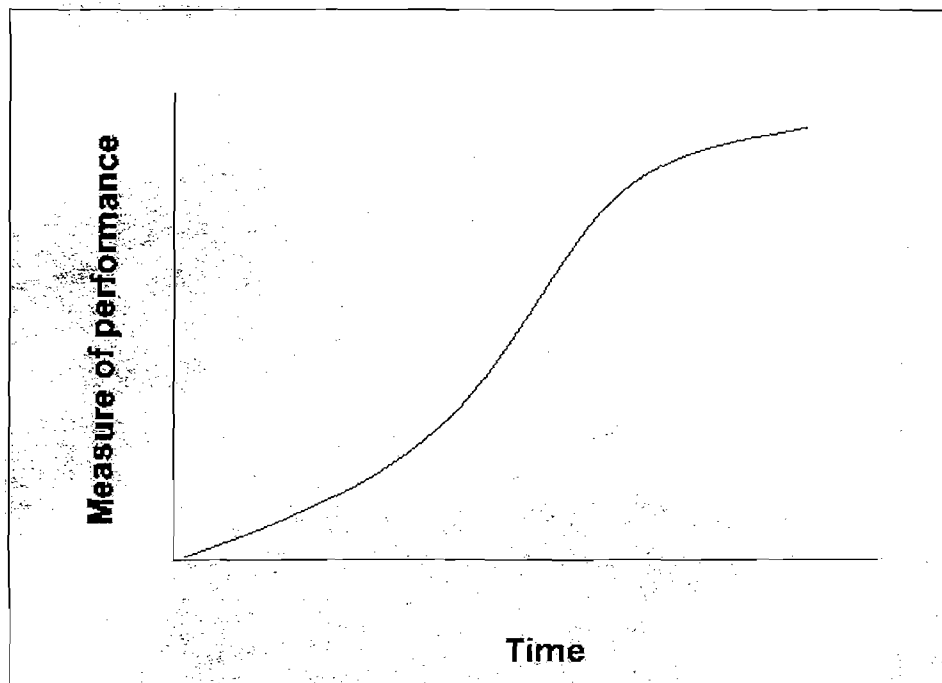


Figure 12: The Technology S-Curve (Burgelman *et al.*, 2001:124)

As Christensen (Burgelman *et al.*, 2001:124) explains, this S-curve is a useful framework for describing the substitution of new for old technologies at the industry level. It represents an inductively derived theory of the potential for technological improvement, which suggests that the magnitude of improvement in the performance of a product or process occurring in a given period of time or resulting from a given amount of engineering effort differs as technology becomes more mature.

Radical new technologies are frequently developed and brought into the industry by *entering* firms, rather than the incumbent leaders. The tendency of leading firms to reinforce and refine maturing technologies and their failure to spot new, successor technologies in a timely manner, is the primary reason why leading firms lose their positions of industry dominance. For example, EMI was initially successful with their CAT (Computerised Axial Tomography) scans, but within six years of its introduction into the market the company had lost market leadership, and by the eighth year had dropped out of the CAT scanner business (Burgelman *et al.*, 2001:187).

Christensen proposes three uses of the technology S-curve to managers of technology development (Burgelman *et al.*, 2001:125):

- a) It provides explanations to why alternative technologies have succeeded or failed;
- b) These curves can aid in planning component and architectural development programs; and
- c) A strategy of “riding” the S-curve of conventional technology and of switching component technology behind the industry’s component technology leader will lead to the greatest success.

2.3.3 SWOT ANALYSIS

SWOT is an acronym for “Strengths, Weaknesses, Opportunities and Threats” and provides a framework for analysing these elements in the organisation’s internal and external environments (Ehlers & Lazenby, 2002:62). A resource and/or capability can be regarded as a *strength* when it offers a distinctive competence that gives the company a competitive advantage. On the other hand, the lack of, or deficiency in, a resource that represents a relative disadvantage to a company in relation to its competitors, is referred to as a *weakness*. Both strengths and weaknesses relate to the internal (or micro) environment of an organisation and are concerned with the present situation.

However, there also exist external factors in the market, industry and macro environment that will have an influence on an organisation over the next few years. Those factors resulting in a favourable situation and/or advantage for the company in realising its goals are classified as *opportunities*. In contrast, *threats* are those external factors leading to an unfavourable situation or a hurdle in obtaining the firm’s goals.

As soon as either the weaknesses or the threats list becomes large, this should indicate a warning flag to management. To survive in the new millennium, organisations will constantly have to turn weaknesses into opportunities and convert threats into strengths (e.g. buy-out of or joint venture with a rival company). This can be done in a variety of ways, such as to:

- Add new functionality to improve the strengths and create new opportunities;
- Target new markets when only a few potential customers remain;
- The synergy obtained from the buy out of a rival company and joint ventures will create new opportunities and improve the strengths column.

2.3.4 LINKAGES WITH THE MARKET AND TECHNOLOGY

Another way of analysing an innovation is with the market/technology linkages matrix: the vertical axis represents the destruction and reinforcement of links with the market, while the horizontal axis represents the destruction and reinforcement of links with technology.

Burgelman *et al.* (2001:4) identifies three different types of innovation: *incremental* (adoption, refinement and enhancement of existing services or products, e.g. the next generation of CPUs); *radical* (entirely new product and service categories, e.g. wireless communications); and *architectural* (reconfiguration of the system of components that constitute the product, e.g. miniaturisation of components).

Each of these three types of innovations together with a niche market forms the four quadrants of this matrix, shown in the following figure:

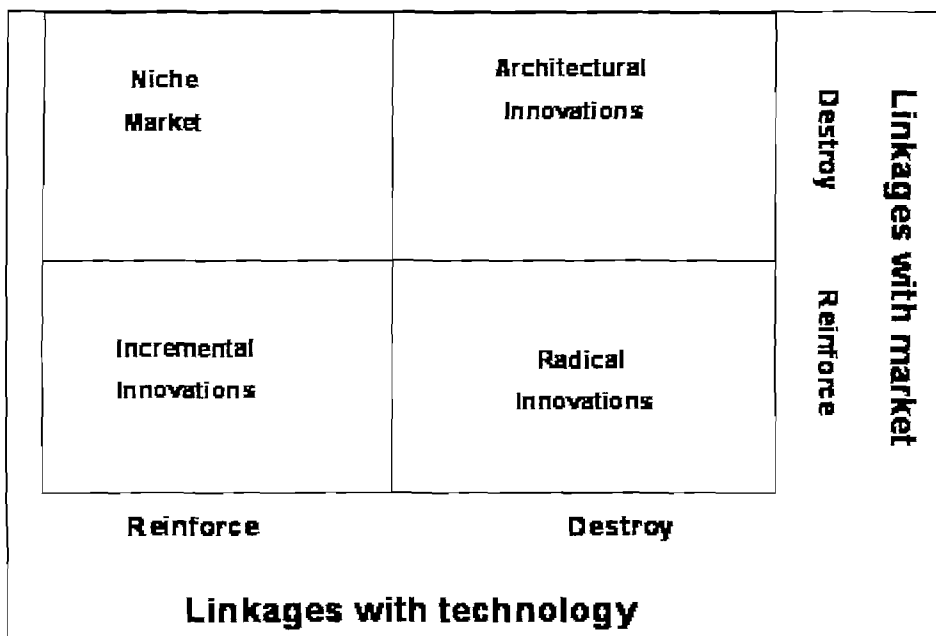


Figure 13: Product Linkages with the Market and Technology (Geldenhuys, 2003b:7)

2.4 CURRENT AND FUTURE EMS TECHNOLOGIES

Burgelman *et al.* (2001:4) refers to technology as the theoretical and practical knowledge, skills, and artefacts that can be used to develop products and services as well as their production and delivery systems. In terms of this definition, a number of technologies are employed by IST Otokon and the industry, which can be subdivided into the following categories:

2.4.1 DEVELOPMENT ENVIRONMENT

2.4.1.1 Technologies Currently Utilised

The software development tools that are currently used by IST Otokon include:

a) *Centura Team Developer (CTD) 2.0*

CTD is a fourth generation programming language (4GL) from Gupta Corporation, providing fast development, quick report generation, and good graphical presentation in the client-server environment (Stevenson, 2003). Version 2.0 (that was used to compile the ecWIN 5 applications) has the added functionality of being able to produce applications accessible through a Web browser, like Microsoft Internet Explorer or Netscape Navigator (i.e. Web applications).

b) *Java Applets*

Java is envisioned to be a programming language producing hardware independent applications (Cornell & Horstmann, 1996:xiv). The point and promise of Java is that it is the universal glue connecting users and information. It doesn't matter whether information is stored on Internet Web Servers, database servers, or any other imaginable source, Java will eventually let you use the Web to access the information, and more.

This means that an Intel PC running Microsoft Windows as the operating system can use exactly the same application as a computer with an AMD processor using Linux as the operating system. Although this is true for the majority of cases, there are many exceptions to the rule; especially where security restrictions prevent certain procedures from functioning correctly.

Tittel *et al.* (2000:299) defines a Java applet as a miniature application that can be embedded in, and interacted with, on a Web page. These applets are composed of code, called class files and are used for a variety of applications for everything from share tickers to chat environments. The profiles in ecWIN 5 are generated by Java applets – these applets are “programmed” with a simple text editor, such as Notepad.

c) HTML and XML

All of the Web reports in ecWIN's eciQUEST module are a combination of HTML (Hypertext Markup Language) and XML (Extensible Markup Language). These reports are edited with a simple text editor (such as Notepad).

d) Microsoft Visual Studio 6.0

The low-level communication to meters in the client/server application ecSERVER (ecWIN's data collection module), is made possible through the use of DLLs (Dynamic Linked Libraries) compiled in Visual C++ 6.0.

e) Report Builder 2.0

This product shipped with Centura Team Developer 2.0 (described above) can be used to build professional reports for client/server applications. All of the reports in ecMANAGER are built on this technology. Unfortunately these reports can not be used with Web applications, such as eciQUEST.

2.4.1.2 Technologies to Utilise in the Future

The first four tools in this list all have successors available in the marketplace; while another alternative for building reports (i.e. Crystal Reports) could be used. These successors and alternative would probably speed up development and could also help to add even more functionality, user-friendliness and a modernised look to ecWIN:

a) Centura Team Developer 3.0 & Centura Team Developer 2005

Stevenson (2003) states that the newest version of CTD delivers major improvements in terms of the speed of compiled applications. Furthermore, some tools have been added to assist the programmer in more efficient programming, such as the Active Coding Assistant (ACA) which is estimated to help programmers complete coding applications up to 20% faster. (The Active Coding Assistant feature displays a choice of available methods or variables).

Also added to version 3.0 is Active Debugging Assistant (ADA) which provides easy and intuitive debugging that further significantly reduces the time to deliver a useable application.

To be launched early in 2005 is Centura Team Developer 2005 (Stevenson, 2005). This version will be able to compile the same source code for use on both the Windows 32-bit and the Linux operating systems. With this feature, previous investments (in time and money) are protected and can be leveraged to support clients not utilising Microsoft Windows.

b) Java IDE

A number of tools are becoming available to speed up and ease the programming of Java applets. One such tool is Sun ONE Studio (formerly known as Forte for Java) – an IDE (Integrated Development Environment) for Java technology developers. Based on the NetBeans Tools Platform, Sun ONE Studio software drives the market forward by providing the latest support for Java and Industry Standards in the development of enterprise class applications and Web services (Anon., 2003).

With tools such as these, visual controls (drop-down boxes, radio buttons, tick boxes, etc.) can be easily placed on an applet's interface and populated with values from an external data source, delivering a highly functional, professional application interface. (Anybody familiar with the use of HTML tags and traditional Java programming will greatly appreciate this functionality!)

c) XHTML

From HTML's humble beginnings, extensibility played no role in the definition of HTML. When Tim Berners-Lee began formulating what was to become known as HTML, he was solely creating a simple way for scientists to exchange papers and other information across a network (Tittel *et al.*, 2000:11).

Accommodating change in HTML has involved huge effort each time. However, XHTML (Extensible Hypertext Markup Language) opens the closed world of HTML, so that users can extend and expand its capabilities.

d) Microsoft Visual Studio .NET

The .NET version of Microsoft's development suite (Visual Studio) consists of Visual Basic, Visual C++ and a new language C# (Ekedahl & Newman, 2003:2). These newer versions of Visual Basic and Visual C++ include improved data management and Web development features demanded by today's developers.

e) Crystal Reports 9.0

According to Ekedahl and Newman (2003:624), Crystal Reports is a powerful reporting tool that allows the developer to design and create presentation-quality reports using a visual designer. The reports can be used in desktop applications or displayed in a Web browser such as Microsoft Internet Explorer.

2.4.2 COMMUNICATION MEDIA

2.4.2.1 Technologies Currently Utilised

One of the most important functions of an AMR (Automatic Meter Reading) System such as ecWIN is the data collection from hardware devices. This requires the data to travel through

some medium (or a number of different media) from its source to the data collector. Currently ecWIN supports the collection of data via the following communication media:

a) Ethernet

A popular packet-switched LAN technology invented by Xerox PARC in the early 1970s, that appears in virtually all corporate networks as well as many small installations (Comer, 2000:20). A large percentage of meters found in the installed ecWIN systems are directly connected to the data collector through an Ethernet network.

b) GSM

The Global System for Mobile Communications (GSM) is an international digital cellular telecommunications standard (Talplatsky, 2003). The GSM standard was released by ETSI (European Standard and Technology Institute) back in 1989. Since GSM has become the most widely adopted and fastest-growing digital cellular standard, it is positioned to become the world's dominant cellular standard. In Southern Africa GSM is also the cellular standard and is used in ecWIN for data collection (data calls) and alarming (by sending an SMS).

c) PSTN

The Public Switched Telephone Network (PSTN) in Southern Africa - currently under the government backed monopoly of Telkom (Endsor, 2001) – is used in ecWIN for data collection via modems and the sending of faxes.

d) Diginet

The digitisation of the South African telecommunications infrastructure, both switching and transmission, led to the decision in 1985 to implement a dedicated digital data transmission network called DIGINET to support the requirement for data transmission at speeds up to and including 64 kilobits per second (Vella, 2003). This service has proven to be extremely popular and is still growing at 20% per annum, due primarily to the better performance that can be realised over the digital transmission network and its cost-effectiveness over long distances.

IST Otokon uses Diginet to connect its branch in Potchefstroom with the head office in Pretoria. Similarly some of the ecWIN clients connect various locations in their organisations (e.g. AngloGold, Sasol, Kumba Resources). The hardware handles all of the underlying details and to the software this seems like an extension of the Ethernet network.

e) Fastnet

Fastnet is a cellular network providing asynchronous wireless access to Telkom's X.25 network, Saponet-P. A base station is the hub of each cell and consists of a transmitter/receiver, processor and 64 kb/s Diginet connection to Saponet-P. A cell typically has a radius of 25 kilometres, but like any UHF (Ultra High Frequency) radio system this is dependent on the topography and building density of the area. Fastnet technology is already used to communicate with some of the meters in ecWIN.

2.4.2.2 Technologies to Utilise in the Future

The following technologies have become quite popular over the last couple of years and could possibly be integrated into ecWIN:

a) WiFi

Wireless Fidelity (WiFi) - also known as wireless internet access or its technical name, IEEE 802.11 - is giving users cable-free Internet access (Stones, 2002). WiFi provides connectivity over a short distance, typically up to 150m, although in testing environments larger distances are obtainable. A wall- or ceiling-mounted radio device picks up the signal, and can connect it to a central network because the receiver is wired into the fixed-line network.

Unfortunately, Telkom is threatening legal action against any organisation using this technology commercially until the second network operator has been approved. Hopefully this problem will be solved soon. This could mean that new ecWIN systems could be less costly to clients, since no network cables have to be installed to the meters (typically installed in electrical substations).

b) GPRS

General Packet Radio Service (GPRS) enables "always on" internet access via mobile phone and is a stepping stone towards the third, ultra-fast generation of mobile networks (Anon., 2002a). GPRS could possibly be an alternative for using GSM data calls to collect data from devices.

It is important to note that with GPRS, costs are determined on the amount of data sent, usually in amounts of MB (Megabytes), with 1 Megabyte = 1 024 kilobytes = 1 048 576 bytes. This is totally different than the current situation, where costs are based on the amount of "air time" used.

c) MMS

Multimedia Messaging Services (MMS) allows picture and video-clip messaging. "We need to break the perception that content on your phone is expensive," said

Vodacom Managing Director Pieter Uys, calling MMS "SMS on steroids" (Anon., 2002a). MMS could be used to send more detailed information (than the currently used SMS messaging) to the mobile phones of ecWIN users.

d) *BlueTooth*

BlueTooth is an open specification for a cutting-edge technology that enables short-range wireless connections between desktop and laptop computers, personal digital assistants (PDAs), mobile phones, printers, scanners, digital cameras and even home appliances — on a globally available band (2.4GHz) for worldwide compatibility. In a nutshell, BlueTooth unplugs digital peripherals and makes cable clutter a thing of the past.

As stated by Franklin (2004), BlueTooth is wireless, automatic, and has a number of interesting features that can simplify our daily lives. By using this technology new capabilities, e.g. free alarming to a user when a certain condition appears in the system (e.g. a meter's power is switched on or off), can become a reality.

2.4.3 PROTOCOL CARRIERS

2.4.3.1 Technologies Currently Utilised

Once the data is handed over by the meter to the communication media, some carrier must take the responsibility for delivery to the destination. Protocol carriers already available in ecWIN include:

a) *RS-232/RS-485*

These two popular standards in the serial communication world, were used with ecWIN before the use of LANs became much cheaper and made the implementation of protocol carriers like IPX communication possible. In cases where no Ethernet network exists, these protocols are still used for data collection in ecWIN today.

b) *IPX*

Novell's NetWare made the use of the *Internet Protocol eXchange* (IPX) popular worldwide. Because of IPX's dominance in the market place in the early 1990's ecWIN's network functionality was initially centred on the use of IPX: Apart from using an RDBMS (relational Database Management System) running on Novell NetWare, the PLC (Programmable Logic Control) used in these early systems was the IPX-enabled ecLOG — a PLC from the South African based company CSD, especially developed for ecWIN.

c) *IP version 4*

The *Internet Protocol* became the dominant protocol around the world over the last decade, because it is the basis on which the Internet functions. Over the last few years ecWIN had to adapt to this new protocol environment because more and more clients

switched their IPX networks to TCP/IP. Part of this change was to start using RDBMS systems running on the Microsoft Windows platform (e.g. Microsoft SQL Server). This change also led to the advent of the ecLOG-II, the TCP/IP upgrade of the original ecLOG.

2.4.3.2 Technologies to Utilise in the Future

It is envisioned that the following changes will take place in the future of the protocol carrier environment:

a) IP version 6

The *Internet Protocols* current version (IP version 4 / IPv4) is nearing the end of its existence because of a lack of IP addresses for the large number of devices. Although there were many predictions that the IPv4 address space would be exhausted before the year 2000, it now appears that with careful allocation and techniques such as sub netting, proxy ARP and classless addressing, IPv4 addresses will suffice until 2019 (Comer, 2000:148). However, the fact still remains that IP version 6 (IPv6) will be launched in the future, which will most probably require ecWIN to make provision for this new protocol carrier.

2.4.4 PROTOCOLS

2.4.4.1 Technologies Currently Utilised

Protocols can be viewed as the “language” used to communicate between devices. Already available in ecWIN are:

a) Electronic mail (e-mail) protocols

As discussed in section 2.1.6.4, ecALARM is the alarming module of ecWIN and can send notifications to end-users through e-mail (or schedule ecSMS to send an alarm through ecSMS). In ecWIN 5 there is currently support for two widely used e-mail (electronic mail) protocols:

- SMTP (Simple Mail Transfer Protocol) – the standard transfer protocol for the exchange of mail between machines (Comer, 2000:518); and
- IMAP4 (Internet Message Access Protocol) – an alternative for SMTP/POP3 that uses the same general paradigm (Comer, 2000:522).

There is currently no provision for the processing of received e-mail messages.

b) MODBUS

Almost all SCADA (Supervisory Control And Data Acquisition) software comes with a MODBUS driver (DCI Technologies, Inc., 2004). Because of its popularity, MODBUS is

also the protocol used to communicate with the ecLOG / ecLOG-II (introduced in section 2.4.3).

c) Propriety protocols

In ecWIN 5, the following propriety protocols are implemented:

- ION (Integrated Object Network) – This is the protocol used to communicate with the meters produced by Power Measurement in Canada;
- Enermax – The protocol required to communicate with Strike Technologies' Enermax meters; and
- ABB – A protocol very similar to the Enermax protocol, which is used to retrieve information from an ABB Vision meter.

d) DLMS

DLMS, which is the abbreviation for Device Language Message Specification, is a messaging system for exchanging data and control information between devices (applications) in a way that is independent of the communication channel being used and the application function being performed (Anon., 2002b). Today, DLMS is an official IEC standard (IEC 61334), which satisfies the following requirements:

- medium-independent, but simple enough to utilize in low-cost devices and applications;
- minimal protocol overhead, so that DLMS can be used on low-capacity connections;
- applicable to a wide range of products, like meters, switches, protection relays etc.; and
- high life cycle cost of the system (installation, maintenance, extension).

This protocol is used in ecWIN 5 to retrieve data from Landis+Gyr and Actaris meters.

e) OPC

OPC (OLE for Process Control) has done for process control what ODBC (Open Database Connectivity) has done for database communication – it allows different vendor's applications to exchange data through a common interface. As Chisholm (1998:6) notes, only a software interface is supplied by OPC; no specific hardware or network infrastructure is required.

Chisholm also identifies the following possible uses of OPC:

- Alarms on sensor data, e.g. temperature, pressure, flow;
- Alarms on control parameters - open, close, run, stop;
- Updates on status information;
- Status of the hardware connection;

- Status of the local software and subsystem;
- Completion of system sequences such as batches; and
- Exposing any data available.

2.4.4.2 Technologies to Utilise in the Future

There is also a new standard protocol in the metering field, which isn't yet supported by ecWIN:

a) POP3

The Post Office Protocol version 3 (POP3) is used to retrieve electronic mail messages from an Internet mail server (Comer, 2000:520). Using this technology will be just the opposite application of technology than with SMTP: instead of sending e-mail messages, the ecWIN system must receive and process these messages (e.g. a request to send a certain load profile to an end-user).

b) DNP3

DNP3 is a protocol for transmission of data from point A to point B using serial communications. It has been used primarily by utilities like the electric companies, but it operates suitably in other areas (Curtis, 2000).

2.4.5 OPERATING SYSTEMS

2.4.5.1 Technologies Currently Utilised

a) Microsoft Windows

The Windows platform is a mature market and it is expected to grow at 11% (or less) in the coming two to three years (Stevenson, 2004). ecWIN 5 was designed to run under the Microsoft Windows 32-bit environment, i.e. Microsoft Windows 98, Windows NT 4.0, Windows 2000, Windows ME and Windows XP (IST Otokon, 2004a:2). Therefore, the Microsoft environment is found at all of the current ecWIN sites.

2.4.5.2 Technologies to Utilise in the Future

a) Microsoft Windows 2003

The newest version of the Windows Server operating system is Windows 2003. The Windows Server 2003 family takes the best of Windows 2000 Server technology and makes it easier to deploy, manage, and use (Microsoft, 2004b). Since this is the only Microsoft license provided for new server hardware, ecWIN will need to support it soon.

b) Linux

Linux is a UNIX operating system clone which runs on a variety of platforms, especially personal computers with Intel 80386 or better processors (Welsh *et al.*, 1998:3). It was

developed by Linus Trovalds at the University of Helsinki in Finland, with the help of many UNIX programmers and wizards across the Internet.

According to Stevenson (2004), Linux has become pervasive in the industry with over 29% of the server market share and Linux for the desktop has surpassed Apple as the number two vendor of desktop operating systems. Growth for Linux applications is quickly outpacing the Windows platform and offers great opportunities for those who get to the Linux market first. Thus, apart from the new Windows 2003 server operating system, another operating system to consider for future ecWIN support is Linux.

2.4.6 RELATIONAL DATABASE MANAGEMENT SYSTEMS

2.4.6.1 Technologies Currently Utilised

a) Microsoft SQL Server 2000

With the lowest implementation and maintenance costs in the industry, SQL Server 2000 delivers rapid return on data management investment. Benchmarked for scalability, speed, and performance, SQL Server 2000 is a fully enterprise-class database product, providing core support for Extensible Markup Language (XML) and Internet queries (Microsoft, 2004a).

This product is the RDBMS (Relational Database Management System) currently used with ecWIN 5.

2.4.6.2 Technologies to Utilise in the Future

a) MySQL

The MySQL database server is the world's most popular open source database. Over five million installations use MySQL to power high-volume Web sites and other critical business systems — including industry-leaders like The Associated Press, Google, NASA, Sabre Holdings and Suzuki (MySQL, 2004).

The use of MySQL is thus an attractive alternative to higher-cost, more complex database technology currently used with ecWIN (i.e. Microsoft SQL Server).

2.4.7 REMOTE ADMINISTRATION TOOLS

2.4.7.1 Technologies Currently Utilised

a) VNC

VNC (Virtual Network Computing) software makes it possible to view and fully-interact with one computer from any other computer or mobile device anywhere on the Internet. (RealVNC, 2004).

This product is currently not used with any ecWIN system, but only on the IST intranet, for remote administration purposes.

2.4.7.2 Technologies to Utilise in the Future

a) Symantec pcAnywhere

Symantec pcAnywhere 11.0 is the world's leading remote control solution (Symantec, 2004). By installing this tool at all ecWIN sites will make it easy for helpdesk personnel to resolve server and workstation problems, without leaving their offices.

2.5 SUMMARY

In this chapter, the focus company (IST Otokon) was introduced as a major role player in the energy management field of South Africa. After looking at recent financial results, the work force and the main customers, the company's flagship product (ecWIN) was discussed.

Following the brief discussion of energy management and the energy management industry, the field of technology management was introduced. This led to the description of specific technology management models (i.e. the Industry Life Cycle, the Technology S-curve, SWOT analysis and Linkages with Markets/Technologies) which will be used in the next chapter to analyse IST Otokon and ecWIN.

Finally, available and future technologies (relating to the technology's current availability in ecWIN) were discussed, in particular the development environment, communication media, protocol carriers, protocols, operating systems, RDBMSs and remote administration tools. From this discussion it was apparent that, although there are a number of technologies currently employed in ecWIN, there are many available which could be used to improve the effectiveness of IST Otokon's energy management systems even more.

In the empirical research discussed in the following chapter, some of these technologies will be examined in the ecWIN environment. This chapter will also describe a questionnaire to measure the current effectiveness of ecWIN.

3. EMPIRICAL STUDY

3.1 INTRODUCTION

The newly found knowledge from the literature study will be applied in this chapter. Firstly, the company, industry and market will be analysed. This will be followed by matching the technology management models to ecWIN. Some of the future technologies (not yet included in ecWIN 5) will also be evaluated. Afterwards, a questionnaire to be completed by the major ecWIN customers will be described.

3.2 ORGANISATION ANALYSIS

Although the focus of this study is to identify new technology to improve the effectiveness of IST Otokon's energy management systems, useful recommendations can't be made without understanding the dynamics of the organisation (which will be discussed in this section).

3.2.1 SWOT ANALYSIS OF IST OTOKON

In section 2.3.3 the SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis was described as a tool to evaluate an entity, such as a company or a product. A SWOT analysis of IST Otokon reveals the following:

Strengths	Weaknesses
The company has recently been registered as an ISO 9002:2002 company; which is becoming a requirement for the tender process.	IST Otokon had a large employee turn over in the last year, mainly caused by the move from Potchefstroom to Pretoria
IST Otokon has the first-mover advantage: ecWIN system already measure 13% of South Africa's generated electricity.	The profit margin is quite low (just above 5% as shown in section 2.1.2).
The organisation has highly skilled staff: as shown in section 2.1.4.2, of the 27 employees there are PhD, six with Masters degrees and seven other graduates.	Being part of a large company with high overheads (R 573 000 in the last financial period) resulted in high hourly rates, which might be a problem for price-sensitive customers.
Reliability and reputation of the company: one of the systems has won an Eskom <i>eta</i> award in 1997 and two others were finalists in 1999 and 2000 respectively.	Company morale is low, as was indicated by a score of 34% from a company-wide climate survey in July 2004.
IST has a broad customer base (discussed in the next section on market analysis).	The internal communication (especially hampered by having two operating offices)

	can be much improved.
The market share held by IST Otokon can be increased (see the next section).	The employee composition (from section 2.1.4.3) isn't representative of the population; BEE compliance is becoming more important with the awarding of major contracts.

Opportunities	Threats
The introduction of Eskom's DSM (Demand Side Management) has opened the door for plenty of new opportunities in the industry.	Some competitors (like HVAC) have already beaten IST Otokon to the punch with DSM projects at ecWIN customers (e.g. AngloGold).
Expanding the CCPF (Centralised Central Processing Facility) to collect different customer's information to a central Web site (especially in the residential and commercial market), is a major opportunity for IST Otokon.	Other firms providing similar services to the proposed CCPF (e.g. Power Measurement Technologies) already have a market presence.
A great number of large industries and municipalities have limited or no energy management tools. These entities can become new clients.	IST Otokon's dependence on hardware suppliers who constantly fall behind schedule has created an unfavourable image at some clients.

Table 3: SWOT Analysis of IST Otokon

3.2.2 ORGANISATIONAL STRUCTURE REVISITED

Earlier (in section 2.1.4.1) the organisational structure of IST Otokon was classified as a matrix management structure. The major advantage of this structure, i.e. specialist project managers that can manage complex projects while the advantages of functional specialisation is retained (Smit & Cronjé, 1997:223), is realised by IST Otokon.

Unfortunately the disadvantages of a matrix organisational structure are also part of the reality:

- a) The division of authority has caused soured relations within the management team; and
- b) The subordinates that have to satisfy more than one boss simultaneously are often placed in a difficult situation (Anon., 2000).

3.3 PRODUCT ANALYSIS

In this section, IST Otokon's main product called ecWIN (currently in version 5), will be analysed by utilising the technology management models discussed in section 2.3.

3.3.1 THE INDUSTRY LIFE CYCLE (ILC) AND ecWIN

In terms of the ILC discussed in section 2.3.1, it can be stated that ecWIN is in the early standardisation phase. The arguments supporting this statement are:

- Fewer new technological designs – every competitor uses nearly the same technology;
- The technology is aimed at incremental improvements and it is not easy to differentiate solely according to technology (the market segment should be considered);
- Rapid sales growth is experienced;
- The cost emphasis is increasing;
- Marketing has a high status in new product decisions; and
- The associated risk and uncertainty is low.

3.3.2 THE TECHNOLOGY S-CURVE AND ecWIN

Mapping the technology S-curve of section 2.3.2 to ecWIN, it is estimated that the product has progressed to about 80% on the curve – this is beyond the inclination point. The successor to ecWIN 5.1 (i.e. ecWIN 6) has been envisioned for some time and will need to be designed and developed in the next 12 months.

In certain aspects this new version will only attempt to let ecWIN “ride the current wave” a bit longer: it will use the same underlying technologies currently employed for certain aspects (e.g. using Ethernet or PSTN as communication for data collection and using protocols such as DLMS). However, newer and emerging technologies (identified in this study) must be utilised to help forge the next S-curve (that will become the dominant design in the future).

3.3.3 SWOT ANALYSIS OF ecWIN

In section 2.2.3 a SWOT analysis of the organisation and the industry was made. In this section a different SWOT analysis is composed, which focuses on IST Otokon’s main product, i.e. ecWIN.

Strengths	Weaknesses
The complete ecWIN Suite is developed in-house, i.e. there is access to ALL source code.	A lot of customers complain that the user interface (especially the Web-based part) is difficult to use (see the results of the questionnaire as described in Chapter 4).
The flexible architecture means that different media, protocols, meters, etc. can be used with no or limited software changes.	There are currently only two programmers employed for all the software development needs. Furthermore, almost half their time is used for other responsibilities such as project management.
The Web application architecture means that “thin clients” can access their energy data.	Some reports on the Web-based system are extremely slow.

	A metering protocol standard DNP3 is already available on meters but isn't supported by the data collector module, ecSERVER, yet.
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Opportunities	Threats
If new technologies (identified in this study) can be implemented in ecWIN before it is available in competing products, it will give the company once again a first-mover advantage.	Competing software, e.g. MV-90, DG20, DGC300, P-MAXX, ION Enterprise, etc. (discussed in section 2.1.7) are giving the customers more choice of which system to install.
With some small changes (especially the tariff calculations and integration periods), the software can be used in international markets as well.	SCADAs and/or ERP systems of the future might encapsulate the functionality of ecWIN, causing a separate energy management system to be redundant (as is already the case with ION Enterprise discussed in section 2.1.7.4).

Table 4: SWOT Analysis of ecWIN

3.3.4 THE PRODUCTS' LINKAGES WITH MARKETS AND TECHNOLOGY

In terms of the linkages matrix and innovation types (discussed in section 2.3.4), the first ecWIN systems can be viewed as an architectural innovation, since it destroyed both the linkages with the market and with the technology: it introduced customers who were used to one monthly hand reading to AMR (Automatic Meter Reading).

The jump from ecWIN 4 (still a client/server software product) to ecWIN 5 (Web functionality, e-mail capabilities, SMS tools) also destroyed the linkages with technology, but reinforced the linkages with the market and is thus classified as a radical innovation.

Over the last few years, only a couple of new features were added, as customers required new functionality, while no new technologies were incorporated (i.e. the appearance and growth of ecWIN 5.1). This reinforcement of linkages with the market and technology is seen as *incremental innovation*.

When implementing some of the technologies identified in the literature study (e.g. DNP3, POP3, Crystal Reports, etc.) in the envisioned ecWIN 6, this will once again only reinforce linkages with the market and technology (i.e. an incremental innovation).

However, implementing some of the technologies identified (e.g. a new low cost business model consisting of “open source” products such as Linux and MySQL) could cause ecWIN 6 to be classified as a radical innovation.

3.4 COMPETENCIES & CAPABILITIES VERSUS THE GENERIC TECHNOLOGIES MODEL

The matrix presented below lists the generic technologies required by the different modules of ecWIN, and associates these technologies with the corresponding modules. For each of these technologies IST Otokon’s competency is estimated as a score out of 10. These amounts will help to identify potential shortcomings in terms of competencies and capabilities.

	Competency (Estimated score out of 10)	Principal product applications					
		ecSERVER	ecQUEST	ecALARM	ecMANAGER	ecSMS	ecCONTROL
Generic technologies							
Web based applications (Java, XML, HTML)	7		X				
Client/Server applications (Centura, Visual Basic 6)	9	X		X	X	X	
Low-level programming (Visual C++)	6	X					X
Databases (SQLServer, Oracle, SQLBase)	8	X	X	X	X	X	
Metering protocols (DLMS, MODBUS, ION, DNP3)	7	X					
Communication protocols (GSM, SMTP, IMAP4, GPRS)	7			X		X	
MD Control (Ripple, Power Line Carrier)	5						X
IST Otokon's Average Score	70.00%	75%	75%	80%	85%	80%	55%

Table 5: Competency & Capability versus the Generic Technologies Model

Assuming all the generic technologies listed carry the same weight (i.e. are of similar importance); an average score of 70% is obtained for the company’s generic technology skills.

The average competency score for each module is also determined in the matrix; this is done with the average score of competencies required for each module, once again assuming they carry the same weight. ecMANAGER (with a score of 85%) seems to be the product for which the company’s current competencies are suited best, while ecCONTROL is clearly the module with the lowest score (55%), which is a warning light to IST Otokon. (This situation will be analysed further in section 4.2).

3.5 MARKET RESEARCH ON CURRENT ecWIN CUSTOMERS

In order to improve on the current product offering, it was deemed necessary to gain some insight into the perceptions of current ecWIN customers on the product. This is also supported by one of the secondary objectives (section 1.3.2) of this research, i.e. “Obtaining feedback from current customers on the attributes of the product (e.g. usefulness, user-friendliness, fulfilment of needs, etc.)”

This is seen as marketing research, which can be defined as the “systematic design, collection, analysis, and reporting of data relevant to a specific marketing situation facing an organisation” (Kotler & Armstrong, 2001: 138).

The process consists of four steps:

- a) Defining the problem and research objectives (getting customer feedback on the current product offering);
- b) Developing the research plan (which will be the focus of this sub section);
- c) Implementing the research plan (identifying respondents and getting them to participate in the research); and
- d) Interpreting the findings of the research and reporting these findings in this management report.

After this last step it would be possible to make suggestions to the decision makers on the course of action to follow that will increase the effectiveness of IST Otokon’s energy management systems.

3.5.1 DETERMINING SPECIFIC INFORMATION NEEDS

In order to yield useful findings, the research must thus measure the perception of current ecWIN users regarding the four dimensions of effectiveness (i.e. functionality, user-friendliness, cost/value evaluation and system documentation) as described in section 1.4.1.

Other information which will also be acquired includes:

- Demographic and industry category characteristics;
- Behavioural patterns regarding ecWIN (preferences, dislikes, etc.);
- Most important aspects of the system in the relevant organisation; and
- Whether anonymity is required when reporting on these findings.

3.5.2 GATHERING SECONDARY INFORMATION

Information that already exists somewhere, having been collected for another purpose, is dubbed *secondary data* (Kotler & Armstrong, 2001:144). Some of the information needed for this study could be obtained from external sources, for example similar research already done by IST Otokon or even some competitors.

The use of this secondary information could speed up the research process and will also be less costly. However, to be useful this secondary data has to comply with the following characteristics, described by Kotler and Armstrong (2001:144):

- Relevant (i.e. it fits the research project needs);
- Accurate (i.e. reliably collected and reported);

- Current (i.e. up-to-date enough for current decisions); and
- Impartial (i.e. objectively collected and reported)

Measured in terms of these variables, secondary information (in case it is available) doesn't seem to be very useful:

- The data was not collected with the specific information needs (described in section 3.5.1) in mind. Thus, the available secondary data might not very *relevant*.
- Furthermore, the *accuracy* of the external data can not be guaranteed, since it was collected by other parties.
- Should this external data indeed exist, it was probably collected at a point in the past when technology was less developed as it is today, i.e. this data is not very *current*.
- The *subjectivity* of these findings is also in doubt, since the researchers could have manipulated the data or applied their own perspectives on the findings.

Because of these abovementioned problems, it is proposed that a completely new research is conducted to collect *primary data*, i.e. information collected for the specific purpose at hand (Kotler & Armstrong, 2001:141).

3.5.3 RESEARCH APPROACH

According to Kotler and Armstrong (2001:145), the approach best suited for descriptive research such as this, is a *survey*, i.e. the gathering of primary data by asking people questions about their knowledge, attitudes, preferences and buying behaviour.

3.5.4 SAMPLING PLAN

Although the research will aim to provide information regarding the perception of all ecWIN users, surveying them all will require a sizable orchestrated effort and would take some time. Rather, conclusions will be drawn by studying only a small sample of the total customer population. (The small amount of accuracy lost by drawing a sample outweighs the cost and time requirements of a wider survey.)

Three questions need to be answered at this point:

- a) *Sampling unit: Who* needs to be surveyed?

Only current users of ecWIN systems will be included, i.e. ignoring prospective clients' views since they haven't got any real hands-on experience with the system.

- b) *Sample size: How many* need to be surveyed?

Although larger samples usually give more accurate results, reliable results can be obtained by choosing the sample correctly. If information can be obtained from at least 10 ecWIN users (i.e. 10% of the estimated 100 users), the results will be viewed as indicative of the opinion of all ecWIN users.

- c) *Sampling procedure: How* should the people in the sample be chosen?

The survey will be aimed at key employees at each of the customer sites which had a long-term support contract at the end of September 2004, i.e. the users interacting with the system on an almost daily basis.

To fulfil the research objectives, a *convenience sample* (i.e. the easiest selection of population members from which to obtain information), will be sufficient. This will mean that the sampling error can not be measured, at the trade-off of a lower cost for the research.

Four different options of contact methods could be used (mail, telephone, e-mail and an Internet questionnaire). Any of these will cause the sample to be chosen automatically, i.e. all of the respondents will make up the sample.

It was decided to e-mail the questionnaire to 25 key ecWIN customers at the beginning of October 2004. Respondents were asked to complete and return the questionnaire. (See Annexure B for an example e-mail message). To get to the 10% limit set above, it was envisioned that at least 60% (i.e. 15) of the customers would participate.

3.5.5 FORM OF THE RESEARCH INSTRUMENT

The proposed research instrument is a questionnaire (presented in Annexure A), consisting of:

- 20 closed-end rating scale questions (which rates the respondent attitude as “I strongly disagree”, “I disagree”, “I agree” and “I strongly agree”; with no space for a neutral, non-indicative answer);
- 5 questions on the demographic/industrial characteristics of the customer;
- 5 questions to gain insight in the general needs and dislikes of the respondents; and
- 5 personal questions.

3.5.6 DEVELOPMENT OF THE QUESTIONNAIRE

This questionnaire is set up in accordance to the guidelines spelled out by Kotler and Armstrong (2001:152):

- Each question must contribute to the research objectives.
- Closed-end questions are used to include all possible answers from which the respondents can choose.
- Open-end questions are used to determine what people think and not how many people think in a certain way.
- Simple, direct and unbiased wording must be used.
- Questions must be arranged in a logical order: the first question must create interest and personal questions must be asked last to prevent the respondent from becoming defensive.

The exact composition of the questionnaire is as follows:

3.5.6.1 Closed-end Questions Measuring Opinions

The twenty questions asked in the first section of the questionnaire measure

- Perceptions on user-friendliness of the system (questions 1, 2, and 7);
- Views on the functionality of the system (questions 5, 6, 9, 10, 11,12, 19 and 20);
- Cost/value evaluation (questions 8, 13, 14, 15, 16, 17 and 18); and
- Quality of the system documentation (questions 3 and 4).

3.5.6.2 Closed-end Questions Measuring Demographics/Industry Characteristics

The next 5 questions asked relate to the characteristics and demographics of the customer's industry.

3.5.6.3 Closed- and Open-end Questions Measuring Behavioural Characteristics

The questions mentioned above are followed with five questions relating to the expectations and dislikes of the respondents in terms of ecWIN.

3.5.6.4 Open-end Questions Measuring Personal Characteristics

The last set of questions is related to the personal details of the respondents, including an option to remain anonymous when reporting on these findings.

3.5.7 ANALYSIS OF THE QUESTIONNAIRE

The actual analysis of the questionnaire answers will be discussed in Chapter 4. However, presented in this section is the method which will be used in the analysis.

3.5.7.1 Closed-end Questions Measuring Opinions

The selection made from the four possible options of each question will be entered into a Microsoft Excel spreadsheet. Each question's answer will carry a certain percentage point:

(1) I strongly disagree = 0 %;

(2) I disagree = 33.3 %;

(3) I agree = 67.7 %; and

(4) I strongly agree = 100 %;

except for Questions 9 and 15 which have the inverse of these values, i.e. an answer of (1) is worth 100% and (4) equals 0 %.

3.5.7.2 Closed-end Questions Measuring Demographics/Industry Characteristics

The answers in this second set of questions can be used to determine correlations between the answers above and a specific industry, province or total electricity costs.

3.5.7.3 Closed- and Open-end Questions Measuring Behavioural Characteristics

The score received for the five options in Question 26, will also be entered into a Microsoft Excel spreadsheet and will carry the following weight:

1 = 100 %;

2 = 75 %;

3 = 50 %;

4 = 25 %;

5 = 0%.

Furthermore, important comments (relating to this study) made in the four open-end questions will also be discussed.

3.5.7.4 Open-end Questions Measuring Personal Characteristics

From the personal question asked, the one of most importance for this research document is whether the client would prefer to remain anonymous. In such a case, his/her name will not be published when referencing specific comments and/or answers.

3.6 EVALUATING UNUSED TECHNOLOGIES

In section 2.4 some technologies not yet utilised in ecWIN (but already available) were identified. The researcher's evaluation of these technologies will be discussed in this section:

3.6.1 DEVELOPMENT ENVIRONMENT

3.6.1.1 Centura Team Developer 3.0

IST Otokon purchased the upgrade license of Centura Team Developer (CTD) a few months back. (This purchase of € 4 000 is quite expensive, even with the current exchange rate levels). Compiling the source code of the current ecWIN applications with this new IDE (Integrated Development Environment) worked fine, except for a few hiccups.

However, the Web application (eciQUEST) still couldn't be used on Windows 2003, even after compiling its source code with CTD 3.0. After addressing this issue with the supplier, their response was that another € 4 000 had to be paid for CTD 3.1. This was unacceptable to IST Otokon management, and after failed attempts at getting the upgrade license at a reduced price, the decision was made to investigate alternative development environments.

Unfortunately the news about Centura Team Developer 2005's unique feature of being able to compile the same source code for use in the Windows 32-bit and Linux environments (see section 2.4.4.2), was only revealed too late to evaluate in this research and will therefore need to be investigated in a follow-up study.

3.6.1.2 Java IDE

After downloading and installing the evaluation version of Sun ONE Studio, it was learnt that it was indeed very easy to create visual controls in client/server applications. However, the same functionality was not so readily available in the Web environment, as initially understood from the product reviews. Alternatives thus still need to be found and evaluated.

3.6.1.3 XHTML

As described in the literature study, XHTML is just an extensible version of HTML. After developing a few Web pages, it was learnt that XHTML has similar capabilities to the currently used combination of HTML and XML in the eciQUEST Web pages. However, XHTML also has the same limitation of not having exact control over where text will be placed on the user's screen – the Web browser automatically resize the page to fit the user's screen resolution. It is therefore difficult to create presentation-quality Web reports with this tool.

3.6.1.4 Microsoft Visual Studio .NET

One of the useful features of Visual Studio .NET, is the Microsoft Development Environment (MDE) which is exactly the same for all three products in the Visual Studio suite (Visual Basic, Visual C++ and C#).

However, although the C++ software developed in Visual C++ 6.0 could be recompiled with some ease in Visual Studio .NET, the same was not true for the Visual Basic 6.0 source code. Programs written for version 6 must be significantly modified to work with Visual Basic .NET; this view is supported by Ekedahl and Newman (2003:2).

3.6.1.5 Crystal Reports 9.0

As explained in section 2.4.1, Crystal Reports have the very useful feature that the same report can be used in desktop as well as Web applications. This is a huge departure from the current situation in ecWIN where client/server reports are built in Report Builder and totally different Web reports are built with XML and HTML in a simple text editor, like Notepad.

Since IST Group has a Crystal Reports 9.0 license, it was quite easy to get hold of the software for this evaluation. The preliminary evaluation of this product looks very promising: it only took a few hours to get used to the development environment and develop an example report. The one concern (whether license fees are required per ecWIN site or only per developer) is in the process of being followed up with the supplier.

3.6.2 COMMUNICATION MEDIA

3.6.2.1 WiFi

By using the D-Link DWL-2000AP+ Access Point together with the D-Link DWL-G650+ Cardbus Adapter, it was possible to set up a wireless network between two notebooks within

in a few minutes (including the time to unpack the hardware and scanning through the installation procedure).

However, during the course of this study, no electrical meters readily supporting WiFi could be found, and this issue couldn't be evaluated any further. Should such meters be found, integration into ecWIN will be quite easy, if the personal experience of setting-up a wireless network is anything to go by.

3.6.2.2 GPRS

At this point, it might be necessary to explain the current situation (using GSM data calls) and what is envisioned by utilising GPRS.

a) Current Situation

The combination of ecGCOM and ecSERVER to collect data via a GSM modem was discussed in section 2.1.6.7. Although this configuration is working fine currently, the problem experienced is that the costs are quite high if a number of meters need to be dialled on a regular basis.

This is mainly due to the fact that approximately 30% of the "air time" is used for establishing and disconnecting the call. Examining the log file of the ecGCOM application, it was learned that approximately 140 seconds is spent to read one day's data (i.e. 48 half hourly records) from an ecLOG-II. This represents 30 seconds to connect, almost 2 seconds for reading of each record and 10 seconds to disconnect.

The current costs depend on the contracts in place for the SIM cards used. A typical installation will be:

- **R 30 per month** connection fee for each modem connected to a PLC (by using Vodacom's "Incomer" package);
- **R 70 per month** connection fee for each modem connected to the ecSERVER PC (by using Vodacom's "Data Call" package); and
- Call costs which will depend on the PLC used, the quality of the signal, whether the call is made in peak or off-peak times, the frequency of data reads, etc. The cost on the "Call Package" in off-peak periods is R 1 for the first minute and then 50c for each 30 seconds. Reading one day's data (approximately 140 seconds as explained earlier) will thus cost R 2.50, resulting in a 30 day month's data to cost **R 75**. (If data is collected in on-peak periods, the cost would be even higher.)
- **Total cost** per month for one PLC is thus **R 175**, with a **marginal cost** (i.e. the cost for one additional PLC) equal to **R 105** (= R 30 + R 75).

b) Envisioned Situation

After upgrading both GSM modems and SIM cards to have GPRS functionality, ecSERVER will still use the same TCP/IP packet to receive data from the PLC. However, instead of looking for the PLC on the local network, the Operating System must forward the request over the GPRS network link to the relevant PLC's modem, responsible for delivering of the data request. The PLC must then answer over the same communication channel.

One half hour's data record of an ecLOG-IIb is 689 bytes (= 5 bytes for the year, 3 bytes for the month, 3 bytes for the day, 3 bytes for the hour, 3 bytes for the minute, 7 bytes for the 96 data values).

The costs associated with this situation:

- **R 70 per month** connection fee for each modem connected to a PLC (by using Vodacom's "Data Call" package);
- **R 70 per month** connection fee for each modem connected to the ecSERVER PC (by using Vodacom's "Data Call" package); and
- Data collection costs of **R 2/MB**; the costs are once again depend on the PLC used, the quality of the signal, etc. Since one record of an ecLOG-IIb is 689 bytes, retrieving all data for a 30 day month will be 992 160 bytes (= 689 bytes per record * 48 records per day * 30 days). By allowing for some additional overheads and retries, the total data sent will be approximately 1 MB, equalling to **R 2**.
- The data request sent by the modem connected to ecSERVER is so small (approximately 20 bytes), that its costs are omitted from this calculation.
- **Total cost** per month for one PLC is thus **R 142**, with a **marginal cost** (i.e. the cost for one additional PLC) equal to **R 72**.

After some testing (with the help and advice of third parties such as GSM Communications and Mobifin), it was learnt that the GSM modem attached to the ecSERVER PC wasn't able to handle the TCP/IP packets correctly.

Investigation into this issue led to the discovery that although the GCom modem used on the ecSERVER PC was upgraded to have GPRS functionality, it should also have its own TCP/IP stack (otherwise it tries to use the Operating System's stack). It also seems that having a GPRS modem connected to the PLC through a standard UTP network cable (instead of a serial cable) will result in the situation where the conversion of protocols are no longer needed. Both GSM Communications and Mobifin are currently investigating the possibility of this configuration.

3.6.2.3 MMS

The Multimedia Messaging Service (MMS) is known to the researcher from the use of an MMS-enabled mobile phone. During the evaluation, this technology was used to send a photograph of an ecWIN profile to a mobile phone with ease. This very same principle could be used to also send detailed reports to ecWIN users; especially in the case of an alarm condition. (Much more detailed information could be provided than with the 160 character limit of normal SMS technology).

Another alternative could be to send an SMS message to a meter which will then respond with the requested day's data records; however, the suppliers of meters will need to implement this technology first.

3.6.2.4 BlueTooth

No electrical metering devices, which could enhance ecWIN's effectiveness by utilising BlueTooth capabilities, could be found during this study. This issue can be further investigated in a follow-up study.

3.6.3 PROTOCOL CARRIERS

3.6.3.1 IP version 6

The only protocol carrier identified in the literature study which doesn't form part of the current product offering is IP version 6 (IPv6); this protocol isn't in use yet. It is, however, necessary to be alert to any developments in this regard.

3.6.4 PROTOCOLS

3.6.4.1 POP3

By using the same components used to implement the SMTP protocol in ecWIN, support for POP3 was added to a small test application. By using this program, the specified Internet e-mail box could be interrogated at regular intervals. The moment a new message arrived, it was retrieved and processed to find certain key words; if one or more of these were found a simple text message was sent in response, otherwise the message was ignored. It thus seems that POP3 functionality could be added to ecWIN with ease.

3.6.4.2 DNP3

In the literature study of Chapter 2, DNP3 was identified as a new standard protocol in the metering field. Although there are a number of meters already complying with this standard, no IST Otokon resources are currently committed to the software development needed to support this protocol. This issue should be addressed in the near future.

3.6.5 OPERATING SYSTEMS

3.6.5.1 Windows 2003

The GUI (Graphical User Interface) of Windows 2003 Server is almost exactly the same as other 32-bit Windows operating systems (e.g. Windows 2000 / XP): Start button, point & click functionality, icons on the Desktop, etc.

Preliminary testing of ecWIN with Windows 2003 revealed that the client/server applications (e.g. ecSERVER, ecMANAGER, ecALARM, etc.) worked correctly. However, the Web module (eciQUEST) couldn't register and therefore run. This is mainly due to the development environment used (Centura Team Developer 2.0) which doesn't support this functionality, as discussed in section 3.6.1.1.

3.6.5.2 Linux

As discussed in section 3.6.1.1, the news about Centura Team Developer 2005's unique feature of being able to compile the same source code for use in both the Windows 32-bit and Linux environments, was revealed too late to evaluate in this research and will therefore need to be investigated in a follow-up study. However, should this feature work correctly by simply recompiling all the ecWIN source code, Linux could be supported with ease.

3.6.6 RELATIONAL DATABASE MANAGEMENT SYSTEMS

3.6.6.1 MySQL

After downloading the installation program from the Internet, this RDBMS was installed. Because this RDBMS has similar tools to those of Microsoft SQL Server for creating and querying a database, it was very easy to create a link between ecWIN and a MySQL database. Since it is an "open source" application (like Linux) it may be distributed as "freeware" and could thus be used at price-sensitive clients in the future.

3.6.7 REMOTE ADMINISTRATION TOOLS

3.6.7.1 Symantec pcAnywhere

This remote administration tool was installed at the Nelson Mandela Metropolitan Municipality (i.e. Port Elizabeth). Over the last few months, this has been used at regular intervals to assist the client with problems experienced. Huge savings were thus realised in terms of travelling time and travelling cost. This technology is ready to be rolled out at all ecWIN sites.

3.7 SUMMARY

Throughout this chapter, the literature study of Chapter 2 was brought into context with the reality of the focus company and its products. Firstly, the company, industry and market were briefly analysed to place the remainder of the study in the correct perspective.

Fitting ecWIN to the different technology management models revealed that ecWIN 5 is in the “early standardisation phase” of the Industry Life Cycle (ILC) and already beyond the inclination point of the technology S-curve. The SWOT analysis has also discovered weaknesses and threats that must be addressed to improve ecWIN.

Experimenting with some of the technologies identified in the previous chapter was also briefly described. Finally, a questionnaire completed by the major customers of ecWIN was also discussed.

The results from this empirical study will be analysed in the chapter that follows.

4. ANALYSIS OF RESULTS

4.1 INTRODUCTION

Meaningful results are required before one can continue developing the new technology management plan to improve the effectiveness of ecWIN. In order to obtain these results, the outcomes of the empirical research (fitting of the product to technology management models, the questionnaire answers and evaluating technologies not currently utilised) need to be interpreted and analysed correctly – exactly what will be done in this chapter.

4.2 FITTING THE PRODUCT RANGE TO COMPETENCIES/CAPABILITIES

In the previous chapter (section 3.4) it was seen that in terms of the generic technologies used, IST Otokon has scored only 70% in this model. Areas of concern is *Low-level programming (C++)* and *MD Control (Ripple or Power Line Carrier)*, which respectively scored 6 and 5 out of 10. These two technologies are, however, the cornerstone of ecCONTROL and will need to be seriously addressed if IST Otokon wishes to grow in this field and remain an important player in the market. These low scores will then also be the reason that ecCONTROL scored a poor 55% fit with the current capabilities and competencies of the organisation.

ecALARM, ecSMS and ecMANAGER uses generic technologies with which the organisation is very familiar (*Databases, Client/Server and Programming*); thus these three applications scored a very good fit (between 80% and 85%) with the competencies and capabilities. These high scores are also evident in the fact that the least amount of ISO non-conformance reports (i.e. software “bugs”) are received for these three modules.

4.3 REVISITING THE PRODUCT SWOT ANALYSIS

In the SWOT analysis of ecWIN, four weaknesses were identified. All of these can be turned into opportunities by making use of the new available technologies:

- a) *A lot of customers complain that the user interface (especially the Web-based part) is difficult to use.*

By using a Java IDE described in section 2.4.1, a new user-friendly interface can be built in a very short time. This can include new functionality that was not available and/or applicable at the time the current interface was developed. However, as discussed in section 3.6.1.2, Sun ONE Studio didn't live up to the expectations IST Otokon had and another Java IDE tool still needs to be found.

With the collaboration of users (e.g. holding an ecWIN seminar) it will also be possible to make a more user-friendly interface that specifically fits the needs of current ecWIN users.

- b) *There are currently only two programmers employed for all the software development needs. Furthermore, almost half their time is used for other responsibilities such as project management.*

Employing an extra programmer or relieving the software developers of other trivial duties, will ease the pressure on them and shorten the current time scale in which “bugs” are fixed and new features are added.

If this extra programmer has a good C++ background or comes from an MD Control environment, it will be a real bonus. (Not having enough C++ and MD Control skills were identified as serious shortcomings in the previous section).

- c) *Some reports in the Web-based eciQUEST are extremely slow.*

The specifications of the new Centura Team Developer 3.1 state that COM objects created with this IDE are two to four times faster than those compiled with Centura Team Developer 2.0 (used to compile ecWIN’s COM objects). By using this newer IDE the responsiveness of the software can be much improved.

- d) *A metering protocol standard DNP3 is already available on meters but isn’t supported by the data collector module, ecSERVER, yet.*

Adding these metering protocols to the list of currently supported ones, will once again give ecWIN an edge over the competing products that do not yet support them and bring ecWIN on par with those that do.

4.4 QUESTIONNAIRE OUTCOMES

The questionnaire answers received from the ecWIN customers will be used in this section to obtain certain results, according to the procedure specified in section 3.5.6.

4.4.1 CLOSED-END QUESTIONS MEASURING CUSTOMER OPINIONS

4.4.1.1 Summary of Results

Looking at the four sections identified in section 3.5, the scores can be summarised as shown in Table 6.

Section	Average Score	Standard Deviation	Maximum	Minimum	N
User-friendliness of ecWIN	71%	15%	100%	44%	10
Functionality of ecWIN	72%	8%	92%	67%	10
Cost/value evaluation	65%	13%	86%	38%	10
Quality of documentation	62%	14%	83%	33%	10
Total	68%	11%	90%	46%	10

Table 6: Opinions on ecWIN

Thus, assuming that all four sections carry the same weight and that all questions in each section also carry the same weight, the average score from the respondents was 68% with a standard deviation of 11%. The maximum score obtained was 90%, while the lowest score was 46%. All of the standard deviations are only between 8% and 15%, which is an indication that (apart from a few possible outliers) the different responses are in line with one another.

The section measuring functionality of the EMS received the best score (72%), while the quality of the documentation had the worst (62%).

4.4.1.2 High-scoring Questions

The only questions, with an average score of 80% or higher were:

- (6) All of the meters, protocols and communication media needed by my organisation are supported by the standard offering (83%);
- (7) Needed information (i.e. load profiles, consumption reports, etc.) can be easily obtained by using the software tools provided (83%); and
- (12) The output (reports, load profiles, etc.) is neat and professional.

These scores were somewhat expected from what was discussed in the opening paragraph of this research document's problem statement (section 1.2): "...the growth of the package was more entrepreneurial than specification driven: new features were typically only added after a customer or potential customer needed some specific functionality".

Because ecWIN is an in-house developed product, the software tools could thus be changed to assist users in finding specific information easily. Furthermore, the output could be changed to the exact customer requirements.

4.4.1.3 Low-scoring Questions

Specific questions with an average score below 60% were:

- (4) The documentation is sufficient for more advanced features, such as tariff analysis, changing the configuration, etc. (57%).
- (13) New features are thoroughly tested before being deployed to my system (50%).

One of the organisational weaknesses identified in the SWOT analysis of section 3.2.1, was that there are currently only two software developers employed to take care of all software development needs, while balancing their time with other tasks such as project management. In such circumstances, it is expected that less time can be devoted to writing detailed documentation and more intensive testing. (This issue was also addressed in section 4.3).

Furthermore, some of the weaknesses of the organisation (identified in the SWOT analysis of section 3.2.3) could also be linked to this situation:

- Company morale was very low from a recent internal survey – as can be expected, this could cause productivity and quality of work to slip as well; and
- Internal communication can be much improved – for example, software and documentation updates are not timeously deployed to all ecWIN customers because of a lack of communication.

4.4.2 CLOSED-END QUESTIONS MEASURING DEMOGRAPHICS/INDUSTRY CHARACTERISTICS

By combining the opinion questions (1-20) with the characteristics questions (21-25), more detailed and segmented information could be obtained, e.g. the importance of certain features to a certain industry segment of province. Especially when Eskom gets deregulated and REDs (Regional Energy Distributors) come into the market, customers in different provinces might pay different rates for electricity, have other billing systems, have other power quality issues, etc. This subject can form part of a follow-up study.

However, what will be discussed here is the importance of certain aspects of ecWIN to its end-users. The results are presented in the Table 7; from this table it is evident that the verification of the electricity account is by far the aspect of most importance to the ecWIN users. Power quality reporting is the feature rated worst. This issue should be followed up to determine the reason behind this, e.g. insufficient documentation, features not fulfilling customer requirements, software “bugs”, etc.

Section	Average Score	Standard Deviation	Maximum	Minimum	N
Re-allocation of costs	58%	33%	100%	0%	10
Verify electricity account	85%	21%	100%	50%	10
Power quality reports	8%	12%	25%	0%	10
Load control	55%	33%	100%	0%	10
Data mining / analysis	45%	26%	75%	0%	10

Table 7: Importance of ecWIN Features

4.4.3 CLOSED- AND OPEN-END QUESTIONS MEASURING BEHAVIOURAL CHARACTERISTICS

Specific comments made which are relevant towards improving the effectiveness of a typical energy management system are discussed below. However, no comments of note were made in response to Question 26 and this question's answers will not be discussed.

4.4.3.1 *New Features Needed*

With regards to the question on what feature the user would like to be implemented (Question 27), the following responses applicable to this study were received:

- "A more comprehensive and more easy to use tariff comparison tool." – W. van Jaarsveldt, Acting Metering Manager at Nelson Mandela Metropolitan Municipality.
- "Maximum demand indication in real time." – J.J.Z. Swart, Planning & Development Engineer at Kumba Resources Tshikondeni Coal Mine.
- "Power quality tools." – K.E. Arnold, Energy Engineer at AngloGold Ashanti.
- "A more direct comparison and user-friendly of costs for different tariff structures." – H. Maartens, Chief Technician at South African Nuclear Energy Corporation.

The comment on power quality tools can be related to the discussion in 4.4.2, where this feature of ecWIN was rated the least important. The three other comments are all related to the tariffs discussed in the literature study (in section 2.2.3); it serves as an indication of how important the correct handling of tariffs by an EMS (such as ecWIN) is.

4.4.3.2 *Features Most Appreciated*

Looking at the answers of Question 29 (on the one feature users like most about ecWIN) reveals the following:

- "Integration to a range of devices." – Respondent wishing to remain anonymous.
- "The variety of ways that reporting can be done." – H. van Zyl, Technical Analyst at Sasol Synthetic Fuels.
- "Now on Web site." – J.J.Z. Swart, Planning & Development Engineer at Kumba Resources Tshikondeni Coal Mine.
- "The availability of data anywhere on a PC through the network." – C. Broodryk, Field Technician at Sasol Infrachem.
- "Fast accurate and reliable month-end cost allocation." – H. Maartens, Chief Technician at South African Nuclear Energy Corporation.

The integration to different devices could be further enhanced by adding DNP3 data collection to the capabilities of ecWIN. Viewing data through the Web site and/or from anywhere on the network is another important feature to users; therefore it is imperative to enhance the Web interface's user-friendliness.

4.4.3.3 Features Most Displeasing

Answers of note to Question 30 (of the one feature users dislike most about ecWIN) include the following:

- “Not user-friendly (You have to know what and where to look for information needed)” – Respondent wishing to remain anonymous.
- “Unreliability of the data due to spikes and dips caused by bugs in the software” – W. van Jaarsveldt, Acting Metering Manager at Nelson Mandela Metropolitan Municipality.
- “The look of the reports: the reports could be presented better. The report itself is fine, just the displacing thereof.” – J. Rossouw, General Manager at Iskhus Power.

The above-mentioned items are in-line with the results of the close-ended questions (e.g. the issue of not thoroughly testing software), the SWOT analysis results and the striving towards finding alternative software development environments. Recommendations and the subsequent action plan should address these issues as well.

4.5 RESULTS OF EVALUATING UNUSED TECHNOLOGIES

In section 3.6 the evaluation of some technologies not yet utilised in ecWIN (but already available) was presented. From this evaluation, the following results are compiled: unused

4.5.1 DEVELOPMENT ENVIRONMENT

4.5.1.1 Centura Team Developer

The shortcomings of Centura Team Developer 2.0 (currently in use) were identified earlier; it is thus recommended that this license get upgraded. By using this upgrade license (instead of another development environment such as Microsoft Visual Studio), previous investments in time and resources will be protected.

After the refusal of the Centura Team Developer supplier to provide IST Otokon with a reduced price for an upgrade license, the decision was made to investigate alternative development environments.

It should be kept in mind, that a decision to use another main development environment (e.g. Visual Studio .NET) to replace the current Centura Team Builder applications, will require a total redevelopment of already functional software.

The recent news about Centura Team Developer 2005's unique feature of being able to compile the same source code for use in the Windows 32-bit and Linux environments, might be a good enough incentive to acquire the upgrade license and leverage the time and resource commitments put into ecWIN over the past decade. This might also open up a new

market for IST Otokon (i.e. customers not using Microsoft Windows). Evaluating this future software release is discussed as one of the topics for future research in section 5.3.

4.5.1.2 Java IDE

Faster and better quality Web interface development can take place with a decent interface (compared to the current text editor); this suggests that a Java IDE should be used for this purpose. However, other alternatives to Sun ONE Studio still need to be found and evaluated. (This issue is discussed as a topic for future research in the following chapter).

4.5.1.3 XHTML

Since the Web browser automatically resize XHTML pages to fit the user's screen resolution (as with the current HTML/XML combination), the results obtained with XHTML will not be an improvement on the current situation. This technology isn't the solution for quality Web reporting and doesn't need to be used in future ecWIN development.

4.5.1.4 Microsoft Visual Studio .NET

Using Visual Basic .NET and Visual C++ as the tools for developing client/server applications might be a good decision for three reasons:

- Personal experience of the researcher has revealed that there is much more documentation, Internet help, code examples, etc. available for Visual Studio than for Centura Team Developer;
- Finding suitable candidates with experience in this development environment is more likely than the handful of Centura programmers; and
- The common interface used for all components in Visual Studio .NET, will assist the programmers.

However, since Visual Basic 6 programs can't simply be recompiled in VB .NET without undergoing major changes and Visual C++ 6 applications are still working fine even under the newer Windows 32-bit operating systems (i.e. Windows XP and Windows 2003), it is not envisioned that the upgrade of Visual Studio to the .NET framework needs to happen soon.

As mentioned earlier (Section 4.5.1.1), a decision to use Visual Studio .NET to replace the current Centura Team Builder applications, will require a total redevelopment of already functional software.

4.5.1.5 Crystal Reports 9.0

Using Crystal Reports in future ecWIN software developments (especially for Web reports), seems to be a good decision because of the following reasons:

- The fact that the same report template can be used in desktop as well as Web applications is a huge advantage over the combination of Report Builder and HTML/XML technologies currently used;

- Development of Web reports are much easier and faster than using a text editor such as Notepad (to build the current HTML/XML pages);
- The output is much more professional since there is no automatic scaling as with HTML/XML pages.

No further convincing of the power of Crystal Reports 9.0 is needed; it is therefore strongly recommended that this product must be used in future software development.

4.5.2 COMMUNICATION MEDIA

4.5.2.1 WiFi

Integration of WiFi electrical meters into ecWIN seems to be a trivial action as soon as such meters are manufactured. Pressure must be put onto the main suppliers of IST Otokon's metering (Power Measurement and CSD) to add WiFi capabilities to their products. Since no conventional networks need to be installed and maintained, this could seriously reduced the costs involved with an EMS and cause price-sensitive organisations to also considering installing ecWIN

4.5.2.2 GPRS

In section 3.6.2.2, it was seen that a huge cost improvement could be made by rather using GPRS than GSM data calls, both in terms of basic cost and marginal cost. Other advantages of rather using GPRS are listed below:

- Data can be collected during peak times as well, without any additional charge;
- Data can be collected far more regularly on GPRS, since there is not such a big overhead on call connection and disconnection; and
- This ability of data collection at more regular intervals will allow critical meters, only having GSM communication, to become part of a SCADA system on GPRS (because reading a register value from these meters will only require a few bytes to be sent between the master station and the meter).

GPRS should thus become part of the EMS offering of IST Otokon. At the time of compiling this report, IST Otokon was still awaiting the modem suppliers' feedback on when a modem with a UTP port will be available. The moment this happens, the testing can be completed and an evaluation site can be brought into existence.

4.5.2.3 MMS

The normal (and already available) MMS technology could be readily applied in ecWIN to improve its effectiveness and should therefore be added as a standard feature. For example, sending a detailed month-end cost reallocation report and/or load profiles to a user's mobile phone when he is not in the office.

As discussed earlier in section 3.6.2.3, another alternative would be that an SMS could be sent to a metering device requesting some data. The meter then responds with an MMS message (holding the relevant data) to the master station, which must then be unbundled by ecWIN and stored in the database. This could have a cost advantage which can be verified as soon as the MMS technology is implemented on a meter. However, meters supporting MMS to send a specific day's data records could not be found during this research and pressure could be put on suppliers of meters to start supporting this technology.

4.5.2.4 BlueTooth

Another technology which seems very promising towards improving ecWIN's effectiveness (by free alarming without any additional cabling) is Bluetooth. As with WiFi and MMS, no electrical metering devices readily supporting this technology could be found. Once again, Power Measurement and CSD must be requested to implement this technology in their hardware.

4.5.3 PROTOCOL CARRIERS

4.5.3.1 Protocol Carriers

The only protocol carrier identified in the literature study which doesn't form part of the current product offering is IP version 6 (IPv6); this protocol isn't in use yet. It is, however, necessary to be alert to any developments in this regard to get the "first mover advantage".

4.5.4 PROTOCOLS

4.5.4.1 POP3

The current ecWIN system supports the sending of e-mail messages when a certain alarm occurs or on scheduled times (through ecALARM). By applying this principle in reverse, a new feature could be added to ecWIN, where a user sends a data request (e.g. the current instantaneous load of the total site) via an e-mail message to the ecWIN system, which then causes the system to answer with the correct value.

In the discussion of the empirical research, it was explained how easily this protocol could be implemented in software to provide this "e-mail message on demand" explained above. A specification should be drawn up on the format of the messages to be sent and received; thereafter the relevant software development can commence.

4.5.4.2 DNP3

To beat competitors to the punch, it is advised that this standard metering protocol becomes part of the current EMS offering as soon as possible. Implementing this protocol might open the door to other markets and/or customers. If no action plan is laid down for its implementation, it will probably only be done once a "Request for Quotation" requiring this functionality has been advertised at a major client, and then it will probably be too late!

4.5.5 OPERATING SYSTEMS

4.5.5.1 Windows 2003

The fact that Microsoft Windows 2003 is the only Windows Server operating system shipped with new hardware makes it very important that ecWIN must support this operating system. Despite the disappointment of not being able to upgrade the Centura Team Developer 3.0 license at a reduced price (to a version supporting Windows 2003), this operating system should no longer be ignored.

As recommended, the upgrade license of Centura Team Developer 3.1 (or even Centura Team Developer 2005) should be acquired to assist in solving this issue.

4.5.5.2 Linux

The rapid growth of Linux in the server arena has been discussed earlier. Although no prospective clients have yet indicated their desire to use ecWIN on Linux, it might happen in the near future. Porting to this operating system must thus seriously be considered.

Since using other development tools for this purpose will result in a total redevelopment of already functional software not being able to run on the Linux platform, Centura Team Developer seems to be the solution. If the Centura Team Developer 2005 route is followed (as suggested in section 4.5.1.1), this problem will be solved, since the same source code could be compiled for both Windows and Linux platforms. IST Otokon's investment in time and resources into Centura Team Developer could thus be leveraged into the Linux domain.

4.5.6 RELATIONAL DATABASE MANAGEMENT SYSTEMS

4.5.6.1 MySQL

Since integration with ecWIN is straightforward and the RDBMS might be distributed as "freeware", the use of MySQL is thus an attractive alternative to higher-cost, more complex database technology currently used with ecWIN (i.e. Microsoft SQL Server).

4.5.7 REMOTE ADMINISTRATION TOOLS

4.5.7.1 Symantec pcAnywhere

All ecWIN customers should be contacted to inform them about the advantages of installing this (or a similar) remote administration tool on one of the ecWIN computers at their site. (Each customer might, however, have its own infrastructure and/or security policies that would have to be addressed).

Especially the sites which are not near IST Otokon's operating offices could hugely benefit from this increased responsiveness in problematic situations, which will also increase the effectiveness of the energy management system installed.

4.6 SUMMARY

In this chapter, the results obtained in the empirical study were analysed. Firstly it was seen that there is a mismatch between one of the product features and the capabilities of IST Otokon. The weaknesses of the product identified earlier were also analysed and recommendations were made on how to turn these into opportunities.

Looking at the results of the questionnaire completed by ecWIN users, the issues that need to be addressed were highlighted. Lastly, the results of the new technologies evaluation were discussed.

This chapter's analysis can now be used to make useful recommendations to the decision makers at IST Otokon on utilising new technologies to improve the effectiveness of their energy monitoring systems – exactly the main focus of the following chapter.

5. CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

The purpose of this study was to identify new technology to improve the effectiveness of IST Otokon's energy management systems. After briefly discussing the organisation and the product (ecWIN), the specific technologies currently employed were described.

Possible new technologies that could be used in ecWIN were also discussed from the literature and some of these were evaluated as part of the empirical research. This empirical research also entailed the fitting of ecWIN to different technology management models, to classify it in terms of the linkages with the market/technology and the industry life cycle (ILC). Furthermore, a survey was conducted under current ecWIN users to rate the perceived current effectiveness.

The results of these research methods were all discussed in the previous chapter – these results will be converted into practical recommendations (in this chapter). Issues that need some further research will also be highlighted.

5.2 RECOMMENDATIONS

From the empirical research, and in particular the survey conducted by means of a questionnaire sent to ecWIN customers, shortcomings in the current EMS offering of IST Otokon were revealed.

The effectiveness of ecWIN can be improved by following the recommendations made here, flowing from the newly acquired knowledge gained in this study. These recommendations will be presented in terms of three dimensions:

- Upgrading the currently used infrastructure (i.e. development environment, protocols, etc.) over the next 12 months;
- Improving the cost effectiveness of the ecWIN suite (typically during 2006/2007); and
- Proposing a new business model for ecWIN (which could be used from 2006).

A fourth dimension, consisting of technologies that should not be used at this stage, will also be presented.

5.2.1 UPGRADING THE INFRASTRUCTURE

5.2.1.1 Development Environment

The first issue to address is the development environment, especially in the light that there have been complaints about the user-friendliness and speed of the current offering. An

upgrade of the Centura Team Developer license to 3.1 is therefore suggested; this will also simultaneously address the issue of support for Windows 2003. If the organisation is willing to wait just a couple of months Centura Team Developer 2005 (with its support for Linux) should rather be acquired.

A **Crystal Reports** license must also be purchased; this tool must be used for all future report development (i.e. both Web and client/server applications).

Furthermore, management should decide to either **relieve the current two software developers of other trivial tasks** or **employ an additional developer**. This will address the two lowest scoring questions in the survey (i.e. proper testing of new features and documentation on more complex tasks in ecWIN).

5.2.1.2 Communication Media

MMS can immediately be used in ecWIN to send detailed reports and/or load profiles to end-users.

Pressure must also be put onto **suppliers of metering to include technologies such as WiFi, MMS and BlueTooth** as discussed in the analysis of these technologies (Chapter 4).

5.2.1.3 Protocols

POP3 must be implemented in ecWIN as discussed earlier to allow e-mail messages to be sent “on demand”. Furthermore, **data collection through DNP3** should be added as soon as possible.

5.2.1.4 Operating Systems

As discussed **support for Windows 2003** is a necessity – should the recommendation in 5.2.1.1 of Centura Team Developer 3.1 or 2005 be followed, this issue would also be addressed.

5.2.2 IMPROVING COST EFFECTIVENESS

5.2.2.1 Communication Media

The cost advantage of GRPS over GSM data calls has been illustrated; a real-world **GPRS site should be established and evaluated**. Once again the **support of technologies of WiFi, MMS and BlueTooth** on metering devices must be brought under the attention of IST

Otokon's suppliers; these can cause huge savings in installation, maintenance and operational costs.

5.2.2.2 Freeware

Since both Linux and MySQL is "freeware" (i.e. can be distributed for free), the cost of a new ecWIN system can be seriously reduced. **MySQL can already be suggested to prospective clients**; the same will be true for **Linux if Centura Team Develop 2005 is purchased**.

5.2.3 NEW BUSINESS MODEL

5.2.2.1 Remote Administration

By using the **remote administration tool pcAnywhere at all ecWIN sites**, a much more effective service could be delivered to the client (especially the remote sites). This could lead to a huge saving of travelling time and cost to IST Otokon and will thus have a quick return on investment (ROI).

5.2.2.2 Centralised Central Processing Facility (CCPF)

Expanding and aggressively marketing the CCPF put in place at IST's offices for the Spornet project must be undertaken. Because the costs to the client is limited to the installation of a meter and operational costs (e.g. dialling the meter and printing a report), IST Otokon can directly attack PMT's market share, despite having high overheads from IST Group.

Cost-effectiveness will be the key and especially rather using GPRS or WiFi than GSM data calls, seems to be the solution.

5.2.2.3 Entering the Commercial/Residential Market

Money is not as freely available in these two sectors as at the industrial customers. As with the CCPF, **cost-effectiveness** will be the key. The client could choose between having his own system (comprising of "freeware" products such as Linux and MySQL) or use the CCPF infrastructure. Because the only other costs to the client will be for the installation of a meter and operational costs (e.g. dialling the meter and printing a report), IST Otokon can make huge inroads in this market.

5.2.4 TECHNOLOGIES NOT CURRENTLY APPLICABLE

From the study undertaken, it is recommended that the following technologies should not be pursued any further at this stage:

- XHTML – it doesn't compare favourably with the current HTML/XML or the envisioned Crystal Reports solution.
- Visual Studio .NET – Visual Studio 6 applications are still working fine under the newest Windows operating system and there is thus no need to upgrade at this stage. Furthermore, should the decision be made to upgrade to .NET, all Visual Basic applications will need serious modifications.
- IPv6 – This standard is still in its final development stages. It is suggested to wait before addressing this issue, until the standards are finalised and router suppliers (e.g. Cisco) implements this protocol.

5.3 TOPICS FOR FUTURE RESEARCH

5.3.1 MORE CUSTOMER FEEDBACK

In the empirical study it was discussed that the survey was done only under current users of ecWIN who had long term maintenance contracts at the end of September 2004. However, previous users might have stopped using the system because it lacked certain aspects. Furthermore, new users without a maintenance contract in place could also have a different perspective with good suggestions. Therefore, a good follow-up study would be to **include the previous and prospective users** in the questionnaire as well.

It might also be worth the time and effort to **get feedback from more users** than the 10% used for this study. This would increase the accuracy of the results obtained and one might also gain good suggestions from the open-ended questions.

Correlations could also be made between user opinions and the user's industry or region, e.g. when the REDs (Regional Energy Distributors) come into effect electricity process might be different between regions and therefore more emphasis could be placed on cost savings.

An **ecWIN user seminar** with think tanks could also be arranged before developing of ecWIN 6 commences, which could also lead to great new ideas.

After addressing the issues identified in this research document, the respondents of the survey should once again be questioned to **determine if the effectiveness of ecWIN did indeed improve.**

5.3.2 MORE RESEARCH ON DEVELOPMENT ENVIRONMENTS

As mentioned earlier, the news about the unique feature of **Centura Team Developer 2005** to compile the same source code for Windows as well as the Linux environment was received very late in the duration of this study. This promised feature must be evaluated before a decision is made on the purchase of this development license.

Furthermore, a **Java IDE** which can assist in building professional Web sites with controls (such as drop-down lists, radio-buttons, etc.) could not be found during this study, but must still be followed up.

5.4 SUMMARY

It was the objective of this study to identify new technology which can improve the effectiveness of an IST Otokon energy management system (EMS). It can be concluded that this primary objective has indeed been reached, on the basis that all of the secondary objectives (identified in Chapter 1) have been attained:

Firstly, a detailed overview of IST Otokon's current EMS offering (ecWIN) was given, including a discussion of competitive products, an analysis of current technologies utilised, a SWOT analysis and a mapping of the product to various technology management models.

Secondly, the user survey (conducted by means of a questionnaire) has provided the organisation with feedback on the current effectiveness of ecWIN.

Thirdly, current (and future) technologies not yet implemented in ecWIN have been identified from the literature.

Lastly, these technologies have been evaluated to determine whether improvements in ecWIN's effectiveness could be achieved by utilising it. These evaluations also led to recommendations together with applicable time frames.

The world of technology is changing at such a rapid pace, that parts of this report might be obsolete by the time it reaches the decision-makers. However, it is imperative that the recommendations made are seriously considered and (if approved) implemented with the needed priority.

Through constant environmental scanning and a follow-up study, other technologies could be identified to improve the effectiveness of the IST Otokon EMS offering, ecWIN, even more.

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ANNEXURE A – QUESTIONNAIRE

MEASURING OPINIONS REGARDING THE EFFECTIVENESS OF ecWIN				
<p>The objective of this questionnaire is to measure the opinion of ecWIN's major users regarding its effectiveness in delivering useful output. Please indicate your true and honest feeling about each of the following statements according to the given scale or options. Your time and effort is much appreciated.</p>				
Section A: Opinions about ecWIN				
<p>Scale 1 = I strongly disagree; 2 = I disagree; 3 = I agree; 4 = I strongly agree</p>				
Nr.	Statement	Scale		
		1	2	3
		4		
1.	The user interface of the client/server applications (i.e. ecMANAGER/ecSERVER/ecALARM) is user-friendly.			
2.	The user interface of the web application (i.e. ecIQUEST) is easy to use.			
3.	The documentation is sufficient for day-to-day activities (e.g. verifying data availability and data integrity).			
4.	The documentation is sufficient for more advanced features (such as tariff analysis, changing the configuration, etc.)			
5.	Most of the needs my company has for energy management can be readily satisfied by ecWIN.			
6.	All of the meters, protocols and communication media needed by my organisation is supported by the standard offering.			
7.	Needed information (i.e. load profiles, consumption reports, etc.) can be easily obtained by using the software tools provided.			
8.	The cost of the product is in line with its quality and performance.			
9.	I'm aware of similar products on the market with better features than ecWIN.			
10.	Data collection and manipulation (i.e. calculations, exporting data, etc.) is happening at an acceptable speed.			
11.	The hardware resources needed by the ecWIN system is of an acceptable level.			
12.	The output (reports, load profiles, etc.) is neat and professional.			
13.	New features are thoroughly tested before being deployed to my system.			
14.	The system is fulfilling its promise of 99% data availability and 97.5% data integrity (with regards to IST's responsibility).			
15.	I'm aware of similar products on the market at a better price.			
16.	Maintenance costs (services, data communication costs, etc.) are acceptable.			
17.	When requesting new functionality, it is added to the software in an acceptable time frame.			
18.	By using ecWIN my organisation was able to save on electrical energy costs.			
19.	I've discovered useful features over time which I didn't realise was part of the system offering.			
20.	ecWIN can give me a competitive edge over my competitors.			
Section B: Demographic, behavioural and industry characteristics				
<p>The following questions will be used to classify the answers above, according to the different industry segments in South Africa. Once again, be true and honest about the answer of each of the following questions.</p>				
21.	My organisation is in the following industry:			
	a) Metals, Mining & Manufacturing			
	b) Chemical			
	c) Paper & Pulp			
	d) Services			
	e) Other			
22.	My office is in the following province:			
	a) Eastern Cape			
	b) Free State			
	c) Gauteng			
	d) KwaZulu-Natal			
	e) Limpopo			
	f) Mpumalanga			
	g) North West			
	h) Northern Cape			
	i) Western Cape			

23.	The years I've been using ecWIN:			
	a) Less than 1 year			
	b) Between 1 and 3 years			
	c) Between 3 and 5 years			
	d) More than 5 years			
24.	My seniority in the organisation is:			
	a) Top management			
	b) Senior management			
	c) Middle management			
	d) Other			
25.	My organisation's total electricity costs per month is:			
	a) Above R 20 million			
	b) Between R 10 million and R 20 million			
	c) Between R 10 million and R 2 million			
	d) Less than R 2 million			
26.	Rate the following features of ecWIN in the order of importance to your organisation (1 = most important, 5 = least important)			
	a) Costs re-allocation			
	b) Verifying supplier accounts			
	c) Reporting on power quality events			
	d) Load control and other cost saving initiatives			
	e) Data mining / analysis			
27.	The one feature I would like to be part of ecWIN is			
28.	The one feature of ecWIN that seems redundant to my organisation is			
29.	The one thing I like most about ecWIN is			
30.	The one thing I dislike most about ecWIN is			
Section C: Personal Information				
Please fill in your personal details below. Also indicate if you would like to remain anonymous when reporting on the above findings.				
31.	Name & Surname			
32.	Organisation			
33.	Position held in organisation			
34.	Years at current organisation			
35.	I would prefer to remain anonymous when reporting on the results of this questionnaire			
	a) Yes, please treat the information as confidential			
	b) No, remaining anonymous doesn't matter			

ANNEXURE B – QUESTIONNAIRE E-MAIL

Below is an example of the e-mails sent in October 2004 to ecWIN customers, requesting them to fill in the attached questionnaire and return it to the researcher.

Good day Jeremy,

We at IST Otokon are constantly striving towards improving the product offering to our clients. Therefore we would appreciate it a lot if we could use 5 minutes of your time to complete the attached survey. (If you would prefer to do this telephonically, please just let me know what time will suit you best).

Improving the effectiveness of our energy management systems is also part of the management report I'm compiling to complete my MBA studies. I would therefore like to use your comments and feedback in this questionnaire to give credibility to the report, but if you wish to remain anonymous, please indicate it as such at the last question.

Since the aim of the report is to be of real practical value, I would prefer for you to be as honest as possible when answering the questions.

Your time and effort is much appreciated!

Best regards,

Gerrie Combrink
Energy Software Architect

IST Otokon

tel: +27 12 426 7509

fax: +27 12 426 7320

cell: +27 82 573 0677

www.istltd.com

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