

# **Overcoming the difficulties of IT system integration in enterprises by establishing an information system engineering environment**

**Submitted in partial fulfilment of the requirements of the  
Master's Degree in Information Technology**

**by**

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**in the**

**Department of Information Science**

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**December 2000**

## ACKNOWLEDGEMENT

I would like to thank all the people who contributed on this book, especially my husband Sello Masenya and his parents for being supportive, my two sons Kgotso and Lethabo for being patient and understanding, my parents Elecia and Ezekiel Moabelo for giving me a moral support, Prof Roode for giving me strengths, my supervisor Prof J. Cronje for his advises and the Almighty who made all this happen. I hope you will enjoy this book. May God bless you all.

T. M. Moabelo

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# Chapter 1

## Introduction to Research

### 1.1 Introduction

This thesis discusses how enterprises can overcome the difficulty of IT system integration by establishing an information system engineering (ISE) environment. An ISE environment addresses system integration problems by providing a collection of methods and techniques, which may be employed within the software development cycle. The use of these methods is designed to improve the software development process by encouraging better design methodologies and thereby producing programmes, which are more easily maintained and contain fewer bugs. Successful system integration efforts also require balancing issues of technical performance, end-user involvement and application of ecosystem/ecological approaches.

### 1.2 Background

The origins of most technology integration programmes stem from a desire to take advantage of the latest technology to improve business operations. Whether the integration effort involves installing a commercial product or a complex system development, there are controllable factors that can contribute to a successful outcome. One key factor for success is a clear understanding of the business operations. A clear understanding of the business operations extends beyond "this is what we do, how we do it and why we do it" (Bell, 1992:14). Understanding the underlying mission or the driving reason behind an operation prevents technology integration from digressing into a technology insertion effort that simply automates the current way of doing business. Maximising the impact of technology integration on business operations is driven by the underlying operational requirements. The relationship of system function requirements to implementation and design issues for system integration will be explored.

Strategies for identifying and defining requirements drawing upon examples from real system integration programmes will be discussed.

A second key factor for successful system integration is the data that will feed the system. Prior to system integration, indeed prior to system design, there must be a clear understanding of the data to be processed or manipulated by the system. For geographic information systems (GIS) technology the complex nature of spatial data increases this factor's impact on the successful outcome of system integration (Blanchard, 1991:67). Technical and political decisions to be made during systems integration often centre on data issues. Deciding between when the system integration should accommodate the quality or structure of legacy data and when the legacy data should be repaired, restructured, or replaced will confront most programme managers. Understanding the technical issues intrinsic to the specific data in addition to the relationship of the data to the business operations is critical to achieving successful solutions. These relationships will be discussed citing real examples from spatial data system integration efforts.

### **1.3 Research Question**

The main question to be answered by this research is:

What is the feasibility of establishing an information system environment (ISE) in relation to the causes of system integration difficulties and the options for system integration success?

The question can be refined by the following sub-questions:

#### **1.3.1 Difficulty with System Integration**

- What is system integration?
- What are the problems that lead to system integration failure?

#### **1.3.2 How to Succeed with System Integration**

- What is Information system engineering environment?

- What is system engineering?
- How does ISE environment solve the difficulties with system integration?

### **1.3.3 End-user Involvement**

- What is the role of end-user involvement to the success of system integration?
- What are the different ways in which end-user can be involved after an information system has been implemented?

### **1.3.4 Ecosystem/ecological Approach**

- What is the ecosystem/ecological approach?
- How does ecosystem approach solve the problems with regard to system integration?

### **1.3.5 Software Runaway Remedies**

- What are the remedies to software runaway?
- How do remedies to software runaways address the problems with system integration?

### **1.3.6 Technical Issues**

- What technical tools are needed for successful system integration?
- What role do these tools play?

## **1.4 Literature Review**

The literature to be reviewed for this study will cover the following topics:

- difficulty with system integration
- how to succeed with system integration
- application of information system engineering environment to address system integration problems
- the impacts of end-user involvement, ecosystem approach, technical performance and software runaway remedies for SI success

## 1.5 Value of the Research

This research will result in:

A set of guidelines leading to successful system integration by:

- establishing Information system engineering environment;
- indicating how user involvement, ecosystem approach and software runaways remedies interact with information system engineering environment to solve system integration problems.

## 1.6 Research Plan

### 1.6.1 Research Type

This research will primarily be a qualitative study, however, quantitative measures will be taken where possible to triangulate the data.

#### 1.6.1.1 Research Timetable

Table 1.1 Research timetable

Activities	Period
1. Literature review	July 2000
2. Final proposal	July-August 2000
3. Design of questionnaires	August 2000
4. Analysis of questionnaire responses	August 2000 - September 2000
5. Research Report	August - October 2000

#### 1.6.1.2 Data collection methods

The methodology for the proposed research is to use a literature study, interviews, checklists and questionnaires, as well as diary and participant observation.

##### 1.6.1.2.1 Description of instruments

- **Literature review**

This covers relevant journal articles, books and electronic documents available on the Internet.

- **Interviews**

Interviews are conducted with systems engineers, system integrators and systems users to validate information obtained from questionnaires and checklists. System engineers who have indicated knowledge information system engineering environment, will be interviewed and consulted, face to face and electronically.

- **Diary**

Observations are noted which pertain to incidents involving interaction with system users.

- **Checklists and questionnaires**

Fill-in, multiple-choice and open-ended questions, paper and electronic, is used to determine the intensity of the information system engineering, user involvement and ecosystem approach for SI success.

#### 1.6.1.2.2 Data collection matrix

Table 1. 2 Data collection matrix

<b>Method / question</b>	<b>Lr</b>	<b>In</b>	<b>Di</b>	<b>Cl</b>
<b>Lr - Literature review; In - Interview, Di - Diary;</b> <b>CL – Checklist/Questionnaire.</b>				
<b>1. Difficulty with system integration</b> - What is system integration? - What are the problems that lead to system integration failure?	✓	✓		✓
<b>2. How to succeed with system integration</b> - What is Information system engineering environment? - What is system engineering? - How does an Information system engineering environment solve the difficulty with system integration?	✓	✓	✓	✓
<b>3. End-user involvement</b> - What is the role of end-user involvement in system integration?	✓	✓	✓	

<b>Method / question</b>	<b>Lr</b>	<b>In</b>	<b>Di</b>	<b>Cl</b>
<b>Lr - Literature review; In - Interview, Di - Diary;</b> <b>CL – Checklist/Questionnaire.</b>				
<b>4. Ecosystem/ecological approach</b> - What is the ecosystem approach? - How does ecosystem approach be applied to address the difficulty with system integration?	✓	✓		
<b>5. Software runaway remedies</b> - What are the software runaway remedies? - How does software runaways remedies address the problems with system integration?	✓	✓		
<b>6. Technical issues</b> - What technical tools need to be used for system integration success?	✓	✓		

## 1.7 Output

### 1.7.1 Overview of Research Report

This thesis is divided into six chapters covering the following:

Table 1.3 Overview of the thesis

<b>Chapter 1</b>	Introduction	Chapter 1 provides the framework within which the problem is situated. It outlines the main points of the study and provides a general overview
<b>Chapter 2</b>	Literature Review	Chapter 2 offers a review of relevant literature on issues related to the success of IT system integration. The following issues are discussed: <ul style="list-style-type: none"> <li>• Difficulty with system integration</li> <li>• Factors that leads to a system integration failure</li> <li>• How to succeed with system integration</li> </ul>

<b>Chapter 3</b>	Research Methodology	Chapter 3 describes research instruments and references will be made to the type of study, as well as the methods, of data collection
<b>Chapter 4</b>	Description of Methodology	Chapter 4 gives a description of the type of research and data will be represented and divided into sections on biographical information of respondents and findings regarding the study
<b>Chapter 5</b>	Research Results	Chapter 5 will provides discussion of the findings and results. This is where the findings will be integrated with theory
<b>Chapter 6</b>	Conclusions and Recommendations	Chapter 6 will give an overview of the study and offers conclusions drawn from the results of the study as well as to provides recommendations in respect of the study

## 1.8 Conclusion

This study will strive to gain further insight into success to IT system integration. This dissertation intends to discover, predominately through qualitative research, how Information system engineering environment overcome the difficulty with system integration as well as the impacts of end-user involvement, ecological approaches, technical issues and software runaway remedies for SI success.

# Chapter 2

## Literature Review

### 2.1 Introduction

#### The objectives of this research

The aim of this research is to investigate the proposition that the successful IT system integration depends on the existence of Information System Engineering environment. The research will also focus on how this Information System Engineering environment can be established to address the problems with IT system integration.

This chapter reports on the results of a literature survey into the topic, beginning with the question, "Is it difficult to succeed with system integration and what causes the difficulties with system integration?". Next to be investigated is how to succeed with system integration. The chapter will then investigate whether the options such as user or client involvement, ecosystem approach and remedies to software runaway has an impact on system integration success, concluding on what technical tools need to be used to solve system integration problems.

### 2.2 Background

System integration has become one of the leading means of delivery for corporations with high quality products and services. Businesses are seeking, not simply to automate existing operations, but to improve and redesign business processes and capture customers' expectations for products and service delivery. Extensive communication and inter-connectivity arising from adoption of standards and integrated services digital networks (ISDN) has become a major force affecting businesses in fundamental ways (Madnick, 1990:45). The second avenue through which businesses are identifying new opportunities is the availability of databases (Madnick, 1990:48).



By linking inter-organisational, inter-functional and inter-personal levels of the processes through IS networks, businesses are not only automating their activities, but are also reshaping and improving their business processes (Hammer and Champy, 1993:69). By accessing 'enterprise-wise' information from databases, IS integration is providing numerous opportunities to coordinate organisational activities by facilitating communication and information exchange across departments without the need to go up and down the vertical chain of command.

The use of information networks to access relevant information from databases has been of enormous importance to eliminate duplicate activities, prevent errors from occurring, cycle time reduction in product development, and customer responsiveness (Davenport, 1993:37). The need of a well-planned database management system is one of the important requirements for system integration. In most organisations, data architecture has evolved as a result of applications databases in various departments rather than as a well-planned data management strategy. Therefore, the resolution of data management problems becomes quite difficult.

The access to timely, accurate and consistent information is crucial in business process improvement. IS integration, through communication networks and database systems, enables organisations to create and sustain process improvement through timely retrieval of consistent and accurate information.

## **2.3 Enterprise Information Systems Integration**

Enterprise information systems integration is defined as the extent whereby various information systems are formally linked for the sharing of consistent information within an enterprise. Enterprise information systems integration is conceptualised along two dimensions: 1) data integration and 2) enterprise communication networking (Madnick, 1990:25). Enterprise communication

networking has been represented along two dimensions: connectivity and flexibility.

## **2.4 Is it Difficult to Succeed with System Integration?**

IS integration is indeed a very big problem. According to Sage & Rouse (1998:1103) system integration is a logical, objective procedure for applying new and/or expanded performance requirements in an efficient, timely manner to the design, procurement, installation and operation of an operational configuration consisting of distinct modules (or subsystems), each of which may embody inherent constraint or limitations. System integration is also defined as the process that combines the practice and application of system engineering and systems management, involving the organisation, management and technical skills necessary for success in system integration programmes, to large complex engineered systems. System integration is also involved with ensuring that specific hardware/software components fit together smoothly in a stated configuration.

### **2.4.1 Factors/problems that Lead to System Integration Failure**

#### **a. Software runaway**

Software takes far longer to complete than originally predicted and that can lead to incomplete software or even software runaway. According to Glass (1998:28) runaways are projects that miss their targets, be that cost, schedule or functionality by over 100%. Software runaway is a project that goes out of control primarily because of the difficulty of building the software needed by the system (Blanchard, 1991:43). The loss of control results in the project becoming unmanageable and the resulting effect is that it is impossible to meet the original target goals. All these runaways are examples of software crisis, that is when the project tends to be: over budget and over time resulting in serious losses; behind schedule; expensive to develop; expensive to maintain; unreliable; unacceptable to users; late and incomplete. All these software problems can lead to the difficulty with system integration.

## **b. Introducing new method and new technology to the organisation**

New technology is not the solution but the cause of the problem, as some of the people do not know how to apply or use it. The combination of inexperienced people using immature technologies is a dangerous one. According to Reilly (1993:123) the first alarming thing to be prepared for is that there will inevitably be a temporary drop in productivity while people spend time becoming familiar with the method. In most organisations there is a hierarchy with the senior and more skilled, perhaps older people, in slightly exalted positions.

A new method can pose a threat to such people. For example:

- they may fear that they will find it impossible to learn or adapt to a new method;
- they may see a new method as a criticism of methods they have used successfully in the past;
- a new method will mean that everyone is a novice again, so that his or her status will erode.

It is generally agreed upon that new methods should be introduced one at a time. If too many new approaches are adopted at once, it is difficult to see which of them is being effective.

## **c. Inadequate/non-existent project management methodology**

Poor management is caused by poor leadership, which could be caused by many factors related to organisational processes. Another cause is the shortage of domain knowledge, which could be either caused by unfamiliarity with the domain or loss of information between organisations (Jackson, 1995:167). With suitable management is often possible to avoid technical confusion, improve planning and stabilise requirements. The historic software engineering belief that poor management is the cause of most software project failures is solidly founded (Grady, 1993:34).

#### **d. Insufficient senior staff on the team**

One of the most important causes of runaway projects is the lack of appropriate people to do the job. Certainly senior, experienced people or knowledgeable people bring enormous value to a project through that experience.

#### **e. Poor design or engineering**

Poor design problems may be caused by system engineers failing to identify errors as well as risks in each and every stage of system development life cycle before integrating the system. According to Jackson (1995:26) problems in the design do not appear until a very late stage in the development process, then they necessitate significant rewriting and redesigning of the programmes.

#### **f. Communication problems**

When two or more people are working on a piece of software they obviously have to liaise with each other. They have to communicate module specifications, modules names, module functions, parameter types and so on. New members who join the team need to be helped to understand what the software is for, what has been done and why the structure is as it is (Aslaksen & Belcher, 1992:78). They may need to learn about the standards and procedures being used on the project or even learn new programming language. This induction of a new person takes up the time of those who remain. All of this adds up to a great deal of time spent in communication that would not be necessary if a single person was developing the software (Blanchard, 1991:34).

#### **g. Lack of clear understanding of the business operations**

A clear understanding of the business extends beyond “this is what we do, how we do it and why we do it” (Bell, 1992:14). Understanding the underlying mission or what is the driving reason behind an operation, prevents system integration from digressing to a system insertion effort that simply automates the current way of doing business. Maximising the impact of system integration on business operations is driven by the underlying operational requirements (Glass, 1998:56).

## **h. Lack of knowledge about technical issues and data that will feed the system**

Prior to system integration, indeed prior to system design, there must be a clear understanding of the data to be processed or manipulated by the system. For geographic information systems (GIS) technology the complex nature of spatial data increases this factor's impact on the successful outcome of system integration. Technical and political decisions to be made during systems integration often centre on data issues. Understanding the technical issues intrinsic to the specific data in addition to the relationship of the data to the business operations is critical to achieving successful solutions (Bell, 1992:16). Additionally, problems such as:

- inconsistent, incomplete and otherwise imperfect system requirements or specifications,
- system requirements that do not provides for change as user needs evolve over time, and
- poorly defined management structures for product design and delivery can lead to delivered products that are difficult to use, that do not solve the intended problems or resolve the stated issue, that operate in an unreliable fashion, that are not maintainable or sustainable, that are difficult to be integrated and that as a result are not used (Grady, 1993:35).

## **2.5 How to Succeed with System Integration**

In order to succeed with system integration, Information System Engineering environment and its capability can be established.

### **a. What is system engineering?**

According to Sage & Rouse (1999:1102) system engineering is seen as the management technology that controls a total system life cycle process, which involves and which result in the definition, development and deployment of a system that is of high quality and is cost effective in meeting user's needs.

System engineering involves the application of methods, tools and techniques to overcome the difficulty with system integration (Sage & Rouse, 1999:1105).

Brinkkemper (1996) defined the following concepts applied by system engineering for system integration success:

- **Methods** can be seen as an approach to perform a systems development project, based on a specific way of thinking, consisting of directions and rules, structured in a systematic way of development activities with corresponding development products.
- A **tool** is seen as a, possibly automated, means to support a part of a development process.
- A **technique** is a procedure, possibly with a prescribed notation, to perform a development activity.
- **Methodology of information systems development** is the systematic description, explanation and evaluation of all aspects of methodological information systems development.

#### **b. What is an environment?**

Oxford Modern English Dictionary (1995:352) defines environment as physical surroundings and conditions, especially as affecting people's lives; conditions or circumstances of living.

#### **c. How does Information System Engineering overcome the difficulty with system integration?**

ISE environment is seen as a remedy to improve the situation. It is an interdisciplinary approach to evolve and verify an integrated and life cycle balanced set of system product and process solutions that satisfy the customer's needs. When physical tools, machines and systems become so complex that it is no longer possible to design them by a single individual who might even be the intended user of the tool or design, problems begin to arise (Davenport, 1993:98). Thus tools and methods associated with system engineering are used to solve all these problems. By using these, it has been possible to develop processes for systems engineering that allow us to decompose the engineering of a large system into smaller component subsystems engineering issues, engineer the subsystem and then build the complete system as an integrated collection of these subsystems (Sage & Rouse, 1999:509).

System engineering provides a collection of methods and techniques, which may be employed within the software development cycle. The use of these methods is designed to improve the software development process by encouraging better design methodologies and thereby producing programmes, which are more easily maintained and contain fewer bugs. System engineering is also intended to give a greater credibility to the design and build quality of the software which is produced, according to Sage & Rouse (1999:26).

System engineering focuses on :

- tools, methods and technologies for the engineering systems
- systems methodology for the life cycle process of definition, development and deployment that enables appropriate use of these tools, methods and technologies
- systems management approaches that enables the proper imbedding of systems engineering product and process evolution approaches within organisations and environments

Each of these three levels is necessarily associated with appropriate environments in order to assure an appropriate system engineering process, including the very necessary client interaction during system definition, development and deployment (Sage & Rouse, 1999:27). The use of appropriate systems methods and tools as well as systems methodology and system management constructs enables the engineering of systems for more efficient and effective human interaction. Most of the methods in system engineering provide a broadly comparable structure, involving the use of diagrams and text for descriptions of the system to be implemented, and the imposition of standards to help to control the quality of the development process at various stages.

We become very concerned with making sure that correct systems are designed by adopting the management technology of systems engineering and applying it (Reilly, 1993:34). The production of systems engineering products that are

correct will be enhanced by appropriate metrics to enable efficient and effective error prevention and detection at the level of system management and at the process and product level. Considerable emphasis should be placed on the front end of each of the systems engineering life cycles to ensure that correct systems are produced. Considerable emphasis needs to be on the accurate definition of a system, including identification of what it should do and how people should interact with it, before the system is developed and deployed.

Bell (1992:17) proposed the following ideas for improving the situation: greater emphasis on carrying out all stages of development systematically; computer assistance for software development, software development environments, Computer Aided Software Engineering (CASE) and fourth generation language (4GLs); concentration on finding out exactly what the users of a system really want; formal specification of the requirements of a system; demonstrating an early version of a system to its customers (prototyping); using new programming languages and greater emphasis on trying to ensure that software is free of errors.

## **2.6 The impacts of ecosystem approach, software runaway remedies user/client involvement and technical performance for system integration success.**

The following are options that are used to overcome the difficulty with system integration: ecosystem approach, software runaway remedies, user involvement and technical support.

### **2.6.1 Ecosystem Approach**

Ecosystem/ecological approach comprises of: information ecology, knowledge ecology, and industrial ecology and system ecology.



### 2.6.1.1 Information ecology

Information ecology involves considering the contexts and impacts of IT on people and organisations (Sage & Rouse, 1999:505). Information ecology is also defined as a system of people, practices, values and technologies in a particular local environment. In each of these settings, humans help other humans to use technology. In the environment of information ecology, technologies are carefully integrated into existing habits and practices, according to the values of the information ecology.

Effective information ecology is associated with four principal characteristics (Davenport, 1993:38):

- integrates diverse types of information
- recognises evolutionary change
- emphasises observation and description
- focuses on people and their information behaviour

All these characteristics lead to major improvements in the ability to accomplish system engineering and management and to enhance participation by all relevant stakeholders in decision making. Access to relevant information and knowledge sharing is very important, as this will help all people involved in the project to understand the system they build.

System engineering is concerned with finding integrated solutions to issues of large scale and scope (Reilly, 1993:56). In order to be successful in solving problems with system integration, system engineers should be seen as brokers of information and knowledge leading to the definition, development and deployment of systems of all types. Managers must also share knowledge with their subordinates so that they will be able to design a good system that will make system integration successful.

According to Sage & Rouse (1999:1110) information ecology provides a perspective on knowledge management principles that can assist organisations in effectively managing what they know. People are required to understand the

role that information plays and the ability to gain access to that information in order to make decisions that will help them on designing a high quality system that lead them to be successful with system integration. This approach includes incentives and rewards systems that provide an important illustration of the effects of ecological forces on information access and utilisation. These systems play important role as they have tremendous impacts on the behaviours of members of an organisation. Information support systems, including decision support can also provide the means for helping people in the project to cope in designing a high-quality system that will make them be successful with system integration.

In order for people to understand the value of information and know what kind of information is relevant, organisations have to develop the capacity to become a learning organisation and to support bilateral transformations between tacit and explicit knowledge. Learning can help the people involved in the project, for situation assessment, detection of a problem, synthesis of a potential solution, implementation of the solution, evaluation of the outcome and discovery of patterns among the preceding processes and all this could help system engineers to be successful with system integration (Davenport, 1993:40). Through learning, people can also learn each and every step in the system development cycle and by understanding all those steps, will help them to be successful with system integration. Thus, learning describes typical problem-solving processes and involves the basic steps of system engineering and management in an inductive fashion.

#### *2.6.1.2 Knowledge ecology*

Knowledge ecology is an interdisciplinary field of management theory and practice focused on the relational and social/behavioural aspects of knowledge creation and utilisation (Sage & Rouse, 1999:507). Its primary study and domain of action is the design and support of self-organising knowledge ecosystems, providing the infrastructure in which information, ideas and inspiration can travel freely to cross-fertilise and feed on each other. Knowledge is also viewed as

transformations of information in the context of a contingency task structure and experiential familiarity (Hammer & Champy, 1993:29). The ecology of knowledge is perceived as a complex, adaptive system of ideas, information, insights and inspiration, interacting with each other and their shared environment.

The following are five principles of knowledge management, by analogy to ecological principles (Davenport, 1993:26): integrates diverse types of knowledge; knowledge capital must inform organisational change; knowledge management must transcend the particulars of the organisation; knowledge management must become ubiquitous; focuses on people and knowledge behaviour.

***a. Integrates diverse types of knowledge***

Knowledge workers should understand knowledge diversity, which requires understanding the relevant facets of organisational activities and the broader context and environment in which the organisation operates

***b. Knowledge capital must inform organisational change***

Definition, development and deployment efforts involve identifying the most appropriate alternatives for organisational advancement and then cultivating them for implementation through use of system engineering process.

***c. Knowledge management must transcend the particulars of the organisation***

Knowledge workers should be empowered through enhancements associated with competence, commitment, communications, collaboration and courage.

***d. Knowledge management becomes ubiquitous***

Listen to and communicate with all knowledge workers to cultivate an intelligence that empowers all and that encourages bilateral transitions between explicit and tacit knowledge.

***e. Focus on people and knowledge behaviour***

All relevant aspects of knowledge are considered in a continuous learning effort that makes knowledge acquisition cycles and processes visible throughout the organisation. By following all this management principles, system engineers can

be successful with the system integration. As part of knowledge ecology, people examine the synergy between software tools and social practices, explore the dynamics around tacit vs. explicit knowledge and experiment with content, context, conversation, community and creativity to understand how knowledge works.

System engineering is inherently associated with knowledge integration and knowledge management across multi-disciplinary boundaries. Therefore, appropriate system engineering efforts need necessarily be associated with systematic measurements to ensure high-quality information and knowledge as a basis for decision making across the three generic systems engineering life-cycles (Aslaksen & Belcher, 1992:45).

### *2.6.1.3 Industrial ecology*

Industrial ecology is viewed as an essential ingredient in appropriate knowledge management (Sage & Rouse 1999:1113). It concerns the effective system engineering and management of industrial processes for the evolution of sustainable products and services. An industrial ecology perspective brings valuable insights and methods to the process of making our products and services more sustainable.

Industrial ecology seeks to integrate simultaneous consideration of product functionality and competitiveness, natural-resource conservation and environmental preservation to produce sustainable development. Such development rests upon three major pillars: techno-economic progress; non-consumptive use of natural resources and environmental preservation, human, social and cultural progress (Jackson, 1995:56).

By considering product functionality, industrial plays an important role as it helps system engineers to be able to see whether the system will function the way it is expected, from the onset. And if so, it also seeks to integrate both the system functionality and the environment on which the system is build, so that systems

engineers can be able to built the system that will help system integrators to be successful (Davenport, 1993:38).

### ***The benefits of industrial ecology***

The benefits of industrial ecology to the product for change include :

- creation of common ground for all project stakeholders to plan effective change
- increased efficiency of energy and material resource use
- ability to target highest risks and opportunities for greatest improvement
- improvements in the efficiency of the products

#### *2.6.1.4 System ecology*

System ecology is the combination of information, knowledge and industrial ecology as well as systems engineering and management concepts, principles, methods and tools (Sage & Rouse, 1999:1114). System engineering is the process of engineering high-quality, trustworthy systems embodied in products and services that fulfil the useful purposes of a client group. This involves planning for and defining a system's requirements and its human interfaces and interactions. The major problems associated with the engineering of trustworthy systems have more do with the organisation and the management of complexity (Reilly, 1993:89).

Attention should not be based only on product or service, but should also be based to associated processes or products lines, so that it cannot leads to the fielding of low-quality, expensive products or services that are unsustainable. Therefore, appropriated systems engineering efforts are necessarily attuned to organisational and environmental realities as they affect the client organisation or enterprise, the system-engineering organisation and the product implementation organisation. System engineering is seen as a catalyst for innovation, quality and productivity (Grady, 1993:78). Therefore, system engineering is associated with the following perspectives:

- Industrial ecology, information ecology and knowledge management efforts, as well as organisational and infrastructure reengineering efforts,

are a natural complement to systems engineering and management perspectives.

- The information revolution and developments in IT combined with tools of industrial ecology and systems engineering and management can produce process-level improvements that lead to the development of successful systems.
- Systems engineering constructs are useful not just for managing large systems engineering projects, but also for creative management of the organisation itself.

By taking all of these perspectives together leads to a system ecology that combines information ecology, industrial ecology, knowledge ecology as well as system engineering and management that leads to successful system integration.

## **2.6.2 Software Runaways Remedies**

### ***Remedies attempted during runaways***

The following are software runaway remedies for system integration success:

#### **a. Extending the schedule**

Extending the schedule may or may not be a simple remedy. For example, if there was a substantive reason for setting the schedule in the first place, such as market opportunity that will be missed if it is not met or a need to integrate the results of this project with another where delay is expensive or the fact that year 2000 is approaching and the system in question must operate connecting in that time frame, then this remedy may be an exceedingly painful one (Reilly, 1993:72). But if the schedule was somewhat arbitrary in the first place, then this remedy is easy and relatively painless.

#### **b. Better management procedures**

This remedy suggests that inferior management procedures were used in the project up to the point of applying the remedy, and that in turn causes one to

wonder why this happened. Improved management was the remedy to be taken towards off future runaways and system integration failure (Glass, 1998:31).

### **c. More people**

Adding more people to a late project makes it even later, as does adding new people into a project requires additional training and learning-curve costs. But if the people added are knowledgeable and experienced in the project, then those training costs and learning-curves are diminished, then they can build a quality system that will be successful with integration (Blanchard, 1991:67).

### **d. More money**

More time costs more money. Another way in which more money can be spent on a runaway without extending schedule is by adding resources in the form of people, equipment and outside services. All these resources can contribute to the system integration success.

### **e. Pressure on suppliers by withholding payment and pressure on suppliers by threat of litigation**

This remedy implies that the project runaway that led to the system integration failure is dependent on one or more outside suppliers. High numbers of organisations became involved in disputes with their outside suppliers, organisation's payments are withheld, threatened litigation and some are sued. There is a dramatic increase in the involvement of the legal system in remedies for runaway software projects (Bell, 1992:17).

### **f. Reduction in scope of project**

It is not always possible to reduce the scope of a project that is to eliminate requirements in order to make the task manageable. But it is usually possible to defer some requirements or features in order to meet other targets. The disadvantage of this remedy is that most of the project could not eliminate any requirements (Jackson, 1995:90).

### **g. New outside help**

There is an increasing trend in the computing business toward the rise of outside suppliers to assist with, or take over, internal projects. Outsiders with knowledge and experience can help in identifying the risks from the onset. Outsourcing or

facilities management is also regarded as possible solutions to the problems (Sage & Rouse, 1999:504).

#### **h. Better development methodologies and change of technology used in the project**

Changing methodologies and technologies in midstream may be an effective remedy, but it could also traumatise a project and guarantee that the system integration process ends in failure. The time to switch methodologies and technologies is not at mid-project, but at the project's outset (Grady, 1993:66).

#### **i. Abandoning the project**

The only way in which this remedy helps is that it stops or rapidly slows project bloodletting, such as money and resources. But abandoning the project means returning to the previous status quo, which presumably was found faulty in some way or the new project would never have been approved.

#### ***Risk management approach***

Risk management approach is also seen as one of the remedies to the difficulty of system integration. According to Sage & Rouse (1999:1113) the overall system integration plan must include provisions for risk assessment. It is necessary that risk assessment potential from major subcontracts be built in from the onset of the project. Then the position of the corporation and the client must include processes and procedures that examine and assess the impact of risk. Thus, a major part of our overall system integration position must be concerned with risk impact assessment and the ability to complete the necessary programme on time and within budget.

#### **2.6.3 End-user/client Interaction**

End-user involvement is important because the system engineer provides the service for the user. Logically the user should have his say as to what the final product should look like and how it should function, after all it is the end-user that has to work with it. The end-user's involvement is also important because it can help the system engineers to achieve better system quality if system design is based on the user's need, i.e. this may contribute to the success of system



integration and it can also increase user acceptance. To build a system of high quality, the end-user's requests and problems also needs to be effectively handled.

According to Hawk (1992:89) an important goal in getting the end-user involved is to obtain a positive change in user attitudes and perceptions. Olson (1996:90) takes this point further by pointing out that in order to improve user attitudes towards resulting system, they should get involved. According to Carey (1998:48) the user's involvement increase the likelihood that the resulting system will be satisfactory to the user and his needs, as well as the amount of time necessary to complete the development task. The end-user should also know how they should get involved and what role they should play.

According to Carey (1998:78) end-users are involved in different ways after an information system has been implemented, the following which are most important:

- end-user training
- user resistance to change
- user feedback for system evaluation
- user acceptance of the system

Roode & Smith (1989) are of the opinion that user involvement has two important objectives: to achieve improved systems quality and to increase user acceptance. According to Davis (1993:43) a user's overall attitude towards using (accepting) a given system is hypothesised to be a major determinant of whether or not a user actually uses it. Attitude towards using is a function of two beliefs: perceived usefulness and perceived ease of use. Furthermore, Davis suggests that systems design features directly influence perceived usefulness and perceived ease of use.

All factors that play a role in end-user acceptance of system are illustrated in figure 2.1

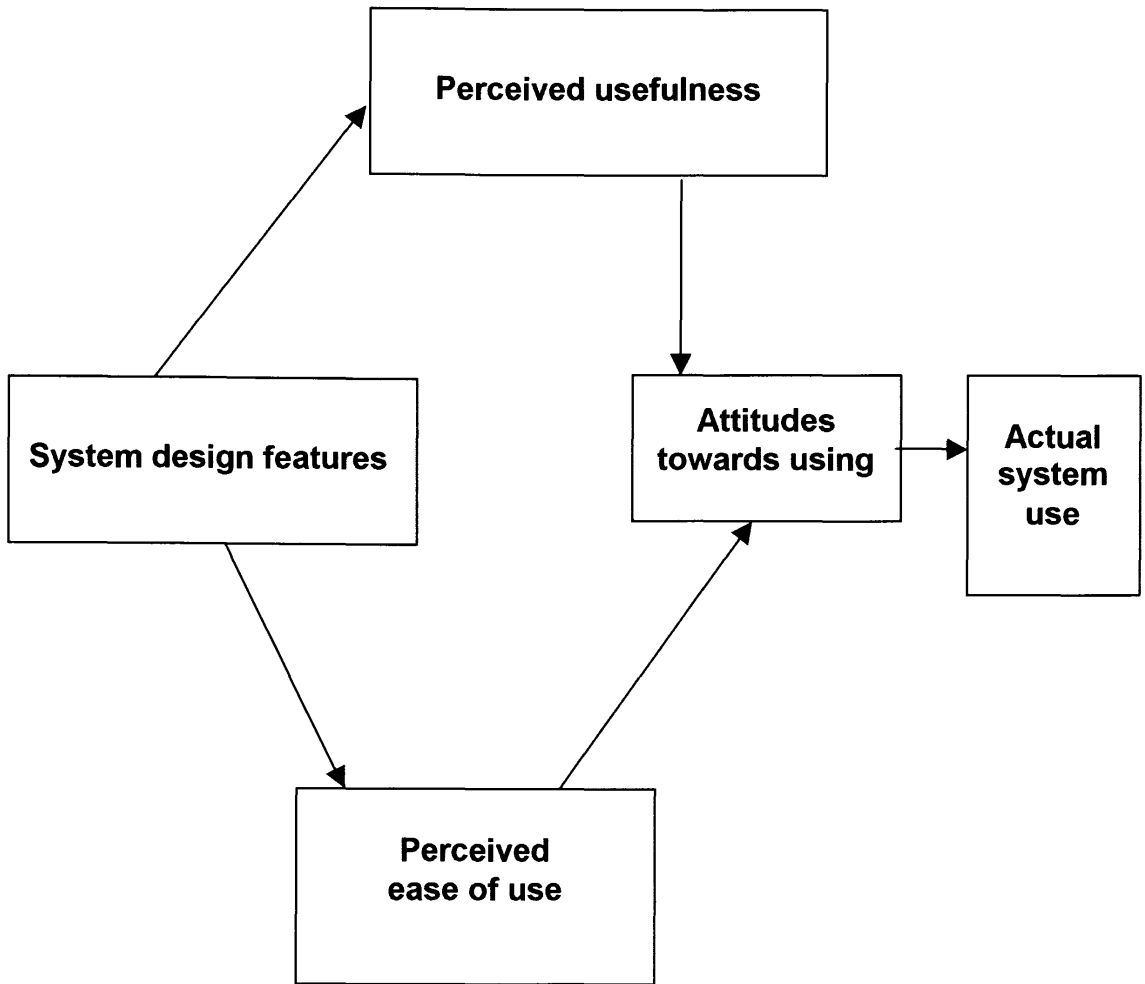


Figure 2.1 Elements of system acceptance (Based on Davis 1993)

User acceptance of given systems is an attitude issue which develops throughout the whole life cycle of a system. Sound relationships between system engineers and end-users will have a positive effect on end-user's cognitive responses towards perceived system usefulness and perceived ease of use, and will therefore contribute towards a higher acceptance rate of information technology by end-users (Carey, 1998:79).

### *2.6.3.1 Definition of system engineer and end-user relationship*

The above mentioned different ways in which end-users are involved before, during and after the implementation of an information system are embodied in so-called 'relationships'. When the end-user initially states his needs for a given business environment, a new relationship grows or develops from that point onwards. The nature of the relationship depends on the business environment that will be involved during the whole system development life cycle. System engineers and end-users need to work together as a team so that they can understand the mission, goals and the norms that they are going to work on.

The norm should be established in the relationship between the end-user and system engineers; functional relationship needs to be created and disagreements need to be negotiated and strengths and weaknesses need to be understood (Hawk, 1992:32). The relationship between end-user and system engineers needs to be cohesive so that the focus can also be on results and performance. They should work together constructively towards common a goal.

The following are important in the relationship between system engineers and end-users:

#### **a. Communication**

Through communication, the parties involved are able to resolve disputes and misunderstandings and align perceptions and expectations. Communication is as important an issue as two-way communication concerns plans, programmes, expectations, goal settings and performance evaluation. Through communication, plans can be coordinated. Communication also keeps the other parties informed (Olson, 1996:45).

Communication enhances successful IT system integration with the environment in the sense that the ideas can be exchanged between system engineers and the end-users about the suitable IT applications and IT infrastructures that can suit the organisation's environment depending on the organisation's mission, vision,

goals and objectives. Through communication, thorough understanding of the environment can be achieved among the end-users and system engineers, i.e. the perception and expectations of both end-users and system engineers may be met (Carey, 1998:64).

### **b. Trust**

Anderson & Witz (1989:56) define trust as confidence and belief in the reliability of truth of each other. Trust is also referred to as a belief that the other party undertakes a coordinative action. Trust attributes the following factors: support provided, goal congruence and cultural similarities. Goal congruence, such as agreeing on goals among members, may be thought of as trust. Low-level trust may increase the risk that individual members will shrink their responsibilities.

### **c. Culture similarities**

Culture in this case refers to the commonly held and relatively stable belief, attitudes and values that exist within the organisation. Culture guides parties in the relationship, i.e. the end-user and system engineer, on correct ways to think and act. It enables them to function on common ground and principles. Cultural difference, for example, is one of the barriers that make it difficult to come to trust the other party. The essence of the problem is lack of shared value and methods, which manifests itself as differences in operating methods and choices (Olson, 1996:77).

All the above-maintained elements are important for the relationship between the end-user and system engineer.

## **2.6.4 Technical Support**

The whole process of development is now commonly carried out entirely on a computer-based system, without any resort to paper (Ford, 1994:23). But not only the developments itself, but the planning, allocation of people, monitoring of progress and the documentation are all maintained on computer. In order to succeed in IS integration it is important to use computer assistance for system development such as CASE tools.

#### 2.6.4.1 Computer-Aid System Engineering (CASE) tools

Developers of IS have historically been the last to apply computer-based tools to improve quality, reliability and productivity on their own work. By introducing CASE technology, they can achieve greater system development productivity while providing a new approach to engineering IS reliably. CASE lets system analysts document and model an IS from its initial user requirements through design and implementation and lets them apply tests for consistency and completeness and conformance to standards (Chikofsky, 1993:39). CASE provides the analyst or system developer with facilities for drawing a system's architectural diagrams, defining and describing functional and data objects, identifying relationships between system components and providing annotations to aid project management.

The user's various work products are stored in an integrated, non-redundant form in a central repository or dictionary on the workstation or on a central server or host system. The system definition as a whole can be checked for consistency and completeness. Analysis can be performed on the information collected or defined to data, thus supporting incremental development and the detection of inconsistencies and errors early in the life cycle (Bell, 1992:18).

CASE development environment for the front end of the life cycle integrates several component tools and facilities:

- The system developer can choose from at least seven basic diagram types, including data flow diagrams, structure charts, entity-relationship diagrams and logical data models. The user can directly create diagrams with the graphics editing facilities on the workstation and then produce those diagrams.
- Information about the user's target system, entered incrementally via diagrams and form screens, is integrated in a central dictionary.
- End-user screens and reports can be developed for the system under design with screen-paint facilities tied to the central dictionary.

- Analysis facilities provide checks for consistency and completeness.
- Deliverable documentation can be organised graphically and can incorporate diagrams and text from the central dictionary.
- An open architecture for access to the central dictionary allows the integration of CASE environment with other tools of the project.
- Established bridges and integrated packages connect the front-end environment to many tools used in later stages of the life cycle.

According to (Chikofsky, 1993:78) organisations using CASE environments have experienced various degrees of improvement in productivity. But many of the user organisations also report that their key gain is in the quality of the system being developed, principally because they can detect errors, inconsistencies and refine specifications easily to reflect their customer's needs. Besides serving as productivity aids, CASE environments provide new opportunities to use analysis techniques to assess the reliability of IS before they are implemented. They also help audit a completed system against its design and maintain the system description as accurate documentation. CASE can also help standardise quality assurance and test processes for systems under-development.

# Chapter 3

## Research Methodology

### 3.1 Research Problem

#### 3.1.1 The Purpose of Research

The purpose of this research was to establish whether the successful system integration depends on the existence of information system engineering environment and options such as ecosystem approach, software runaway remedies, user involvement and technical support

#### 3.1.2 Aim of Research

The aim of the research was:

- To evaluate an information system engineering environment and the options such as ecosystem approach, software runaways remedies, user involvement for system integration success, to establish whether it would be feasible to instate this kind of environment and options for system integration success.
- To expose project managers to an information system engineering environment to determine whether this could provide an alternative method to solve system integration problems.
- To evaluate the affective experience of project managers and system engineers when exposed to an information system engineering environment for system integration success.

#### 3.1.3 Objectives of Research

In order to achieve the aim, the objectives of the research were:

- To expose project managers to existing information system engineering environment.

- To evaluate whether this existing information system engineering environment and options mentioned above were acceptable to project managers, system engineers and system integrators.
- To evaluate whether this existing information system engineering environment and options mentioned above were acceptable as an alternative method for system integration success to project managers and system engineers.

### **3.1.4 Type of Study**

In this study the investigator used interpretive, qualitative methods and humanistic inquiry to collect data.

#### **a. Qualitative research**

Qualitative research is concerned with abstract of characteristics of events (Kincheloe, 1991). In this study, the affective effects of information system engineering environment and its options were qualitatively analysed by using individual interviews. Qualitative research has a holistic view of experiences, as the investigator explores all aspects of an experience. Qualitative thinking involves the feeling and appreciation dimension of human activity. Another important aspects of qualitative research is its concern with context, that it attempts to keep from being constructed or modified. The methods of inquiry must be appropriate to the aims of the study, which describe essential qualities of events, interpret the meanings and relationships between those events.

#### **b. Interpretive research**

During this latter process, the researcher interacted with the human subjects under study, thereby changing the perceptions of both parties (Walsham, 1993). The main aim of interpretive research could be said to be to understand, rather than predict. The researcher was collecting facts and data describing not only the purely objective aspects of human behaviour, but also the subjective meaning has for the human aspects, in arriving at required understanding. Thus the data collected for interpretive research is really the



researcher's construction of other people's construction of what they and their co-workers are doing and thinking (Nandhakumar & Jones, 1997:67).

Klein & Myers (1996:89) noted that there are three reasons for the growth in interpretive research:

- First, through interpretive research, the researcher can study problems in the richness of their real-life setting as contrasted with the artificial context of laboratory studies.
- Second, interpretive research allows the researcher to address issues of causality and human purpose in their complex real-life setting.
- Third, this type of research is often the only way to glean knowledge in a scholarly way in an area that is new or not accessible to quantitative research at all.

### **c. Humanistic enquiry**

The humanistic enquiry is a general term used for a specific non-positivist research approach in which the researcher immerses him/herself in the system being studied, rather than standing apart from it. Knowledge is constructed, not discovered, thus humanistic enquiry is thus a form of 'engaged' interpretive research (Nandhakumar & Jones, 1997:75). Direct personal experience, rather than experimentation, is used to collect research data. Humanistic enquiry methods were used to cater for the indeterminate aspects of the establishment of information system engineering environment for system integration success, and to allow the research problem to drive the methods used.

#### *3.1.4.1 Interviews*

Individual interviews were used to determine the affective views of project managers as far as an information system engineering environment and its options were concerned. Individual interviews fall into the category of qualitative research. The following is a brief overview of qualitative research with the emphasis on individual interview:

## **a. Data sources**

### *Observations*

These provided a written account of what the researcher hears, sees, experiences and thinks in the course of collecting and reflecting on the data in a qualitative study

### *Field notes*

It is consisted of **descriptive compartment** and **reflective compartment**.

Descriptive compartment represents the researcher's best effort to objectively record the details of what occurred in the field. Reflective compartment reflects the personal account of the course of inquiry. The researcher took the field notes during the course of this project.

## **b. Analysing qualitative research**

Data analysis is the process of systematically searching and arranging the interview transcripts (Bogan et al, 1993:38). Field notes and other materials accumulated enable researcher to present what he/she discovered to others. Analysis involves working with data, organising it into manageable units, synthesising it, searching for patterns, discovers what is important and what is to be learned, and deciding what you will tell others. Analysis should start in the field while the research is being conducted, followed by encoding of the data. Coding categories have to be determined to assist with coding.

## **3.2 Methods of Investigation**

### **3.2.1 Data Collection Methods**

A number of different data collection methods were used in order to triangulate the findings of this study. Interview research were used to collect information and thus proved qualitative research.

### 3.2.2 Description of Instruments

#### *Observations*

The researcher observed the project managers, system engineers and system integrators.

#### *Interview*

The researcher conducted individual interview with project managers.

#### *Questionnaire*

Questionnaire results obtained for the same sections were compared to the interview results.

### 3.2.3 Data Collection Plan

A data collection matrix as illustrated in table 3.2 indicates which instruments were used to collect information on the various research questions.

Table 3.1 Data collection matrix

Issues	Instruments	Literature	Interviews	Diary	Questionnaire	Observation
Difficulty with system integration		✓	✓		✓	
How to succeed with system integration		✓	✓	✓	✓	✓
End-user involvement		✓	✓	✓		✓
Ecosystem approach		✓	✓			
Software runaway remedies		✓	✓			
Technical support		✓	✓			

## 3.3 Research Design

### 3.3.1 Description of Research Design

This study was based on interview design. The researcher used the individual interview to establish what causes the difficulty with system integration and how

does an information system engineering environment help to overcome system integration problems. In this case the relevant people in the establishment of information system engineering environment for system integration success were conducted. Those people were :

- users of information systems
- IT managers
- project managers

The researcher chose to interview members from the information systems specialist responsible for system integration. However, during some interviews, systems engineers and systems users were also present for an interview. The interviews were purposely conducted amongst senior project managers in order to draw upon their wealth of experience in the field. A total of three interviews were conducted in South African IT companies.

### **3.3.2 Instruments Used in the Research**

#### *3.3.2.1 Interview*

Interviewees were given research questions in advance to make some preparations. Conduct interviews were made at work places.

#### *3.3.2.2 Observation*

The researcher observed the project managers, system engineers and system integrators while they were interacting with information systems. No formal checklist was used for the observations. During observations, the following aspects were concentrated on:

- the project manager's attitudes to an information system engineering environment;
- the effect of establishing an information system engineering environment on project managers.

Table 3.2 Advantages and limitations of individual interviews

Advantages	Limitations
The researcher has more control in an individual interview when compared to group interviews	Individual interviews do not provide a social environment, thus interviewees may not feel free to answer the questions
Participants do not have a chance to be influenced by other interviewees	An interviewee needs a thorough explanation in those questions on which he/she does not have any idea or it is difficult to answer.
Data may be very easy to analysed in comparison to group interview data	Individual interview results have low face validity, and are relative high in cost
Individual interviews do not require a trained interviewer	Individual interviews provide very slow results

### 3.4 Research Time Frame

The research was done from the end of August until the middle of September. During this time different project managers were exposed to the interview questions.

Table 3.3 Research time frame

Week	1	2	3	4
Date	25 Aug – 25 Aug	01 Sept – 05 Sept	10 Sept – 15 Sept	17 Sept – 25 Sept
Action	Preparations of interview questions	Preparations of interview questions	Conducting interviews	Conducting interviews

### **3.5 Setting**

According to Ricken & Boruch (1974, in Babbie, 1992), it is often appropriate and important to measure aspects of the context within which the experiment is conducted. The research was done in Nissan IT department, BMW IT department and Telkom IT department, all in Pretoria. During the interviews some background information from each interviewee about him/herself and about the organisation was also gathered, in order to place their remarks in context. Interview 02 was conducted in one of the largest companies in South Africa (Telkom, 120 000 employees). It was chosen because of the big role that IT play in this very large company. Emphasis was placed, however, on organisation that had a relatively long history of system integration or on information systems professionals in those organisations with a relatively long experience of information systems development.

### **3.6 Summary**

In this study, qualitative and interpretive methods were used to answer the research questions. Individual interviews were conducted to establish how the project managers and system engineers experienced the use of information system engineering environment and options such as ecosystem approach, software runaways remedies and user involvement for system integration success.

# Chapter 4

## Research Findings

### 4.1 Introduction

The purpose of this study was to evaluate the use of an information system engineering (ISE) environment and the options such as ecosystem approach, software runaway remedies and user involvement for system integration success in South African companies. In order to achieve this, a number of methods and instruments were used. These were discussed in chapter 3. The results of the analysis of the data gathered by these instruments will be discussed according to six sub-questions in Table 3.2, enabling the researcher to draw a conclusion and make relevant recommendations.

### 4.2 Description of the Target Population

The target population consisted of project managers, system developers and systems engineers in Nissan, BMW and Telkom around Pretoria.

Table 4.1 Types of organisations as well as ages, gender and positions of interviewees

Organisation	Position	Gender	Age	Years in this organisation
Int 01 BMW	Project manager	Male	45 yrs	20 yrs
Int 02 Nissan	Project manager	Female	28 yrs	5 yrs
Int 03 Telkom	Project manager	Female	30 yrs	8 yrs

## 4.3 Analysis of Interview Results

Analysis of the interview results revealed the following:

### 4.3.1 Difficulties with System Integration

The three interviewees expressed differing points of view. These can be synthesised as follows: The process of system integration is indeed a big problem. The research has shown that there are some of the problems that lead to system integration failure.

#### *An analysis of the responses to the questionnaire*

##### **a. Problems that lead to system integration failure**

The results to the statement 1, 2, 3, 4, 5 and 6 are indicated in table 4.2. The statements are tabulated as follows:

Table 4.2 illustrates the problems that lead to system integration failure

<b>A1</b>	<b><i>Incomplete systems or software runaways</i></b>
<b>A2</b>	<b><i>Lack of knowledgeable people to do the job</i></b>
<b>A3</b>	<b><i>Poor management</i></b>
<b>A4</b>	<b><i>Failure to involve the client/user</i></b>
<b>A5</b>	<b><i>Failure to follow all phases in the lifecycle model</i></b>
<b>A6</b>	<b><i>Introducing new technology and adding new people to the project</i></b>



The responses to these statements are plotted together on the same table and the same chart. On the table and the chart, statements 1, 2, 3, 4, 5 and 6 are represented by A1, A2, A3, A4, A5 and A6 respectively.

Table 4.3 The results of system integration problems by different project managers

	Strongly disagree	Disagree	Agree	Strongly agree	Total
A1	0	0	4	2	N=6
A2	0	0	1	5	N=6
A3	0	0	3	3	N=6
A4	0	0	1	5	N=6
A5	0	0	5	1	N=6
A6	0	0	3	3	N=6

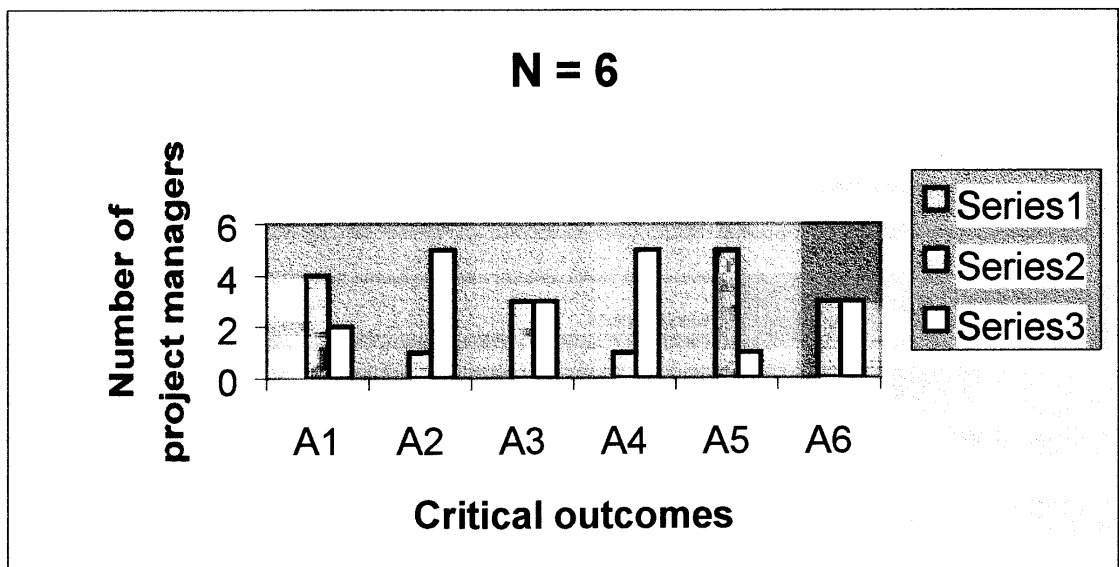


Figure 4.1 Critical outcomes of SI problems for its success problems for its success

The above graph shows how project managers responded to problems that lead to system integration failure. All of them agreed that all the problems illustrated in table 4.2 lead to system integration failure.

The results obtained concur with the literature specified in Chapter 2 that says problems such as poor project management, introducing new technology to the project and lack of knowledgeable people can lead to project failure (Bell, 1992:17). Both interviewees and literature study saw the process of system integration as a big problem. They saw all of the problems mentioned above as the factors that lead to system integration failure.

### **4.3.2 How to Succeed with System Integration?**

The instruments that yielded the best data to answer this question were interviews and observation. These can be synthesised as follows: Interviewees saw an information system engineering (ISE) environment and its options as remedies to overcome system integration problems. Information system engineering environment provides a collection of methods and techniques, which may be employed within the software development cycle. The use of these methods is designed to improve the software development process by encouraging better design methodologies and thereby producing programmes, which are more easily maintained and contain fewer bugs. System engineering is also intended to give a greater credibility to the design and build quality of the software that is produced.

These results were supported by the findings from the questionnaire that states that an information system engineering environment is seen as a remedy to solve the difficulty with system integration. The major objective in systems engineering and management is to provide appropriate products, services and processes that fulfil clients needs. Therefore, each company that is serious with the process of system integration should establish people such as industrial engineers,

computer engineers, manufacturing engineers, systems engineers, mechanical engineers and electrical engineers for this purpose.

### **b. ISE environment and its options for system integration success**

The results to the statement 1, 2, 3, 4, 5 and 6 are indicated in the graph in figure 4.2. The statements are tabulated as follows:

Table 4.4 Statements concerning the possibilities of ISE environment and its options for system integration success

<b>B1</b>	<i>The successful system integration depends on the establishment of ISE environment.</i>
<b>B2</b>	<i>Ecosystem approach can help in solving system integration (SI) problems.</i>
<b>B3</b>	<i>End-user should be involved for system integration (SI) success.</i>
<b>B4</b>	<i>Technical support is needed for system integration success.</i>
<b>B5</b>	<i>Software runaway remedies can help in addressing system integration (SI) problems.</i>
<b>B6</b>	<i>Do you think a life cycle model plays an important role for system integration success?</i>

The responses to these statements are plotted together on the same table and the same chart. On the table and the chart, statements 1, 2, 3, 4, 5 and 6 are represented by A1, A2, A3, A4, A5 and A6 respectively.

Table 4.5 The possibilities of ISE environment and its options for system integration (SI) success

	Strongly disagree	Disagree	Agree	Strongly agree	Total
<b>B1</b>	0	0	1	5	<b>N=6</b>
<b>B2</b>	0	1	2	3	<b>N=6</b>
<b>B3</b>	0	0	1	5	<b>N=6</b>
<b>B4</b>	0	0	3	3	<b>N=6</b>
<b>B5</b>	0	1	2	3	<b>N=6</b>
<b>B6</b>	0	0	3	3	<b>N=6</b>

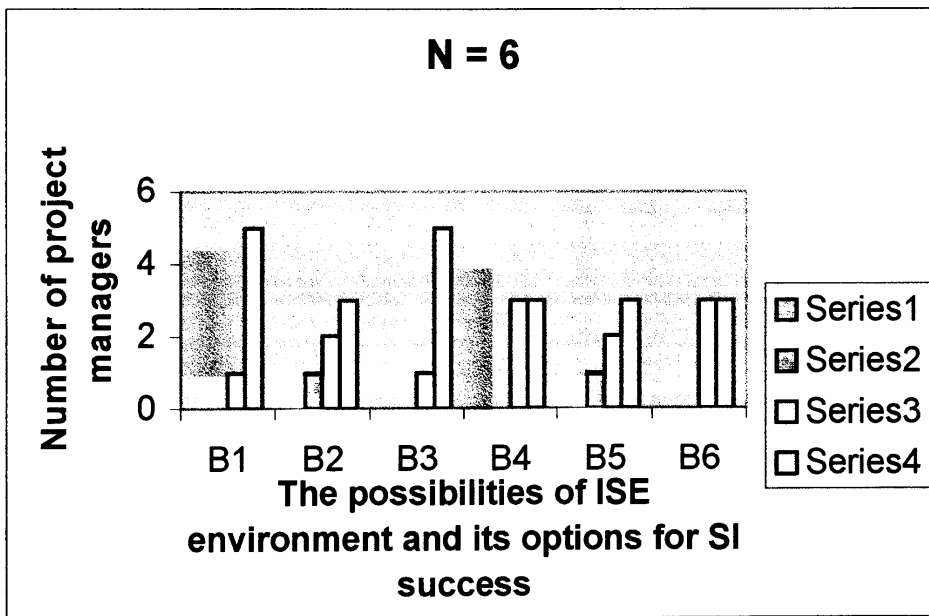


Figure 4.2 The possibilities of ISE and its options for SI success

The above graph shows how project managers responded on ISE environment and its options for success. All the respondents agreed with the statement B1 that establishment of ISE environment can overcome the difficulty with system integration. One respondent added that computer integrated manufacturing can also be used as another alternative environment for system integration success.

The results for options such as ecosystem approach, software runaway remedies user involvement and technical support for system integration success are explained in details in this chapter.

The results obtained concur with the literature specified in Chapter 2 that states that the establishment of an information system engineering environment and the options such as user involvement and technical support can help to address the difficulty with system integration (Sage & Rouse, 1999:512). Table 4.5 shows the possibilities of an information system engineering environment (ISE) and the options such as ecosystem approach, software runaway remedies, user involvement, life cycle model and technical support for system integration success (third interviewee).

The results on how to succeed with system integration, differ with the literature specified in Chapter 2 that states that an information system engineering environment, and its options, can only be used as the remedy for system integration success (Glass, 1998:28). The third interviewee also regarded computer integrated manufacturing environment and life cycle model as another solutions to system integration problems.

### **Computer integrated manufacturing environment**

The third interviewee defined computer integrated manufacturing as an approach to the organisation and management of a firm, in which the functions of design, manufacturing and production management are mutually rationalised and completely coordinated, through the use of appropriate levels of computer and information/communication technologies.

The third interviewee mentioned the following desirable outcomes of computer integrated manufacturing:

Table 4.6 Desirable outcomes of computer integrated manufacturing environment

Strategic outcomes	Operational outcomes
Improved customer service	Improved schedule performance
Improved quality	Lower total cost
Improved competitiveness	Reduced inventories, greater turns
Improved responsiveness, flexibility	Enhanced stability of employment
Greater profitability, long term	Greater manufacturing velocity
Shorter time to market	Lower economic batch quantities
Greater return on assets employed	Shorter vendor lead times
Greater value added per square foot	
Greater market share	

These results differ with literature review findings in that an information system engineering environment and options such as ecosystem approach, software runaways remedies, user involvement and technical support are only seen as remedies to overcome the difficulty with system integration (Grammy, 1993:45). Computer integrated manufacturing environment is not yet recognised as the solution to system integration problems. But if ever the companies recognise its importance on system integration success, then the process of system integration will be better achieved.

Figure 4.3 shows the major element of a manufacturing system that involves product design, production planning and manufacturing. This generic model diagram also illustrates a large number of the manufacturing related technologies that are commonly associated with an advanced manufacturing environment.

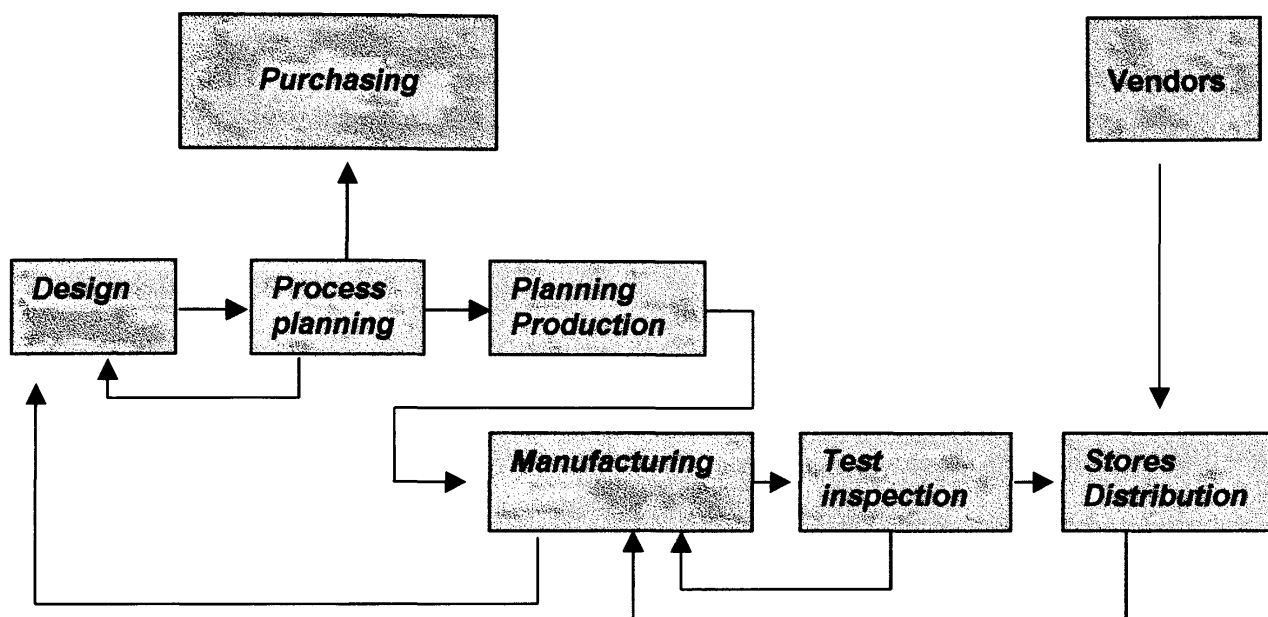


Figure 4.3 A generic reference model for manufacturing system flow

The third interviewee also described the following three fundamentally different approaches to achieving a computer integrated environment.

**Approach 1**

This approach places an emphasis on getting several computerised applications in place and worrying about pulling them together at a later stage. Proponents of this approach argue that a company should build realistically sized modules, then link them into an integrated system.

## ***Approach 2***

This approach to computer integrated manufacturing development is to start at the top (total system), and design a comprehensive system from the very beginning. Proponents of this approach argue that this is the only way to assure that the system pieces will “fit together”.

## ***Approach 3***

A third approach to computer integrated manufacturing, which is a hybrid of the two fundamental paths includes the best features of each. At the company-wide level, a general framework for the total system can be specified. This framework would include standard communication protocols, a data dictionary, standard file structures and so on. Then, individual modules are implemented through time, each having been designed using the overall framework and standards. This approach is sometimes called, design from the top, implement from the bottom.

The first interviewee opposed the above results by describing some barriers to achieve computer integrated manufacturing environment. They are: Non-standard communications protocol; inadequacy of integrated methodology; lack of understanding of change management; lack of appropriate methodology for justification and lack of qualified system integrators.

### ***a. Non standard communications protocols***

The lack of a standard format for the electronic exchange of data between components is the biggest problem.

### ***b. Inadequacy of integrated methodology***

There is no commonly understood methodology for achieving system integration. The approaches being used are largely intuitive and ad hoc. They are also highly fragmented, with each technique applied to individual functions.

### ***c. Lack of understanding of change management***

Even more traumatic than the changes in our equipment and processes will be the pervasive changes that system integration will require in the social aspects of the factory. System integration will require that we re-think our traditional



approach to organisation design. It will also require new approaches to management practices at all levels.

***d. Lack of appropriate methodology for justification***

Traditional approaches to justifying the cost of acquisition of individual pieces of equipments are inadequate for justifying a comprehensive upgrading of a manufacturing system.

***e. Lack of qualified system integrators***

There is a tremendous shortage of qualified engineers and systems analysts/designers who know how to properly use the available technology. To overcome all these system integration problems, the research recommended information system engineering environment and options such as the life cycle model and user involvement as remedies.

**System engineering life cycle model (Framework approach)**

According to the third interviewee, all phases in the life cycle model should be followed for system integration success. System engineers, project managers, systems developers and all people who are involved in building a system should understand all phases in the life cycle model.

Table 4.7 Illustrates the phases and steps in system engineering life cycle

	Formulation			Analysis		Interpretation	
	Problem definition	Value system	Systems synthesis	Systems analysis	Alternative refinement	Decision making	Planning for action
<b>Requirements and specifications</b>							
<b>Systems architecting and Preliminary conceptual design</b>							
<b>Logical design and Functional architecting</b>							
<b>Detailed design, physical Architecting and testing</b>							
<b>Operational implementation</b>							
<b>Evaluation and modification</b>							
<b>Deployment and maintenance</b>							

The third interviewee described seven phases and steps in the systems engineering life cycle model as follows:

### a. Steps in the system engineering life cycle model

Table 4.8 Steps in the system engineering life cycle

Issue Formulation	Analysis	Interpretation
<p><b>Problem definition</b> involves isolating, quantifying and clarifying the needs that create the issues at hand and describing that set of environmental factors that constrain variables for the system to be developed.</p>	<p><b>Systems analysis</b> involves determining specific impacts or consequences that were specified as relevant by the value system. These impacts may relate to such important concerns as product quality, market, reliability, cost and effectiveness or benefits.</p>	<p><b>Decision-making</b> involves evaluating the impacts or consequences of the alternative developed in analysis relative to the value system. This enables interpretation of these evaluations such that all alternatives can be compared relative to these values.</p>
<p><b>Value system design</b> involves selection of the set of objectives or goals that guide the search for alternatives.</p>	<p><b>Refinement of the alternatives</b> refers to adjusting, sometimes by optimising the system parameters for each alternative in order to meet system objectives and to satisfy system constraints.</p>	<p><b>Planning for action</b> includes communicating the results of the effort to this point. It includes such pragmatic efforts as scheduling subsequent efforts, allocating resources to accomplish them and setting up system management team.</p>
<p><b>Systems synthesis</b> involves searching for a set of alternative courses of action or options.</p>		

## **b. Phases in the system engineering life cycle**

Interviewees described seven phases in the system engineering life cycle as follows:

### ***Phase 1: Requirements and specification***

Its goal is the identification of client, customer or stakeholder needs, activities and objectives for the functionally operational system. This first phase will help systems developers and project managers to understand exactly what is needed or what the user needs, and this will help them to build a system of a high quality that will enable them to be successful with system integration.

### ***Phase 2: Preliminary Conceptual Design or Functional Architecting***

If the requirements specifications effort indicates that clients needs can be satisfied in a functionally satisfactorily manner, then documentation is typically prepared concerning system-level specifications for the preliminary conceptual design phase. This phase includes an effort to specify the content and associated enterprise level functional architecture for the system product in question.

### ***Phase 3: Logical Design and Physical Architecting***

The primary goal of this phase is to develop some sort of prototype that is responsive to the specifications and functional level architecture previously identified in earlier phases concerned with technical specifications and systems architectures. The following are also included in this phase:

- Design approaches (e.g. bottom-up, top-up, etc.)
- Use of CASE tools and other automated aids

### ***Phase 4: Detailed Design and implementation architecture***

This phase should result in a useful system product. There should exist a high degree of user confidence that a useful product will result from the efforts following detailed design, or the entire effort should be redone or possibly abandoned. Another product of this phase is a refined set of specifications for the evaluation and operational deployment phases of the life cycle. These are translated into detailed representations in physical architecture form such that system production, manufacturing or implementation may occur.

### ***Phase 5: Operational implementation***

Realistic operational test and evaluation can be conducted then user guides for product should be produced. In this phase, the system is manufactured or assembled or otherwise made operational.

### ***Phase 6: Evaluation and modification***

In this phase, the following should be done:

- review and evaluate system functioning
- obtain, install, test and accept modified component
- maintain, modify, augment and enhance systems
- plan for system retirement/replacement

### ***Phase 7: Deployment and maintenance***

This phase includes final acceptance of the system and operational deployment and associated maintenance.

By following all phases in the life cycle model, project managers, system integrators, system engineers and all people who are involved in the projects will be successful with system integration.

#### **4.3.3 What is the Role of an Ecosystem Approach in Solving System Integration Problems?**

The instruments that yielded the best data to answer this question were interviews and observation. These are synthesised as follows: Ecosystem approach is consisting of information ecology and knowledge ecology. System integrators, system engineers and system users should get relevant information and have knowledge about the system they have to build, and this will help them be successful in their system integration

The third interviewee opposed these results by saying that the ecosystem approach is not seen as a good remedy for system integration. People do not recognise the value of information in satisfying their needs. Top managers own information and deny access to people at the bottom. People at the bottom are required to understand the role that information plays and the ability to gain

access to that information in order to make decisions that will help them on designing a high quality system. Information brokers and project managers should take part on providing people with relevant information and how to use that information to solve their problems. This relevant information will help them to build the systems of high quality and they will be successful in the process of system integration.

People also do not have knowledge on how to plan, implement, design, and use the system. To be successful in the process of system integration there should be knowledgeable people to do the job. Lack of knowledgeable people leads to system integration failure, unless the company hires knowledgeable people from the external sources.

The results disagree with the literature specified in Chapter 2 that states that the ecosystem approach can help to overcome the difficulty with system integration, by applying knowledge and relevant information on how to build the systems of high quality (Ford & Woodroffe, 1996: 87). Therefore, first and second interviewee, as well as the literature review saw the ecosystem approach as a good approach to be used to overcome the difficulty with system integration. The third interviewee does not regard this approach as a good remedy to address the problems with system integration as people do not have access to relevant information. This interviewee saw the life cycle model as a good approach for system integration success.

#### **4.3.4 How do Remedies to Software Runaways Help to Solve Integration problems?**

The instrument that yielded the best data to answer this question was the interviews. These can be synthesised as follows: Software runaway's remedies, such as introducing new technology and adding new people to the project, can help project managers to be successful with system integration. People added from the outside can have more knowledge and experience on how to build a

system. These people can aid the project by sharing the knowledge they have with existing staff to build a high quality system that will help them be successful with system integration.

The third interviewee opposed these results by suggesting that remedies to software runaway are not good options to overcome the difficulty with system integration. For example, a remedy such as introducing new technology can delay the project as people do not know how to use that technology or people may have fear in using that technology. Project manager has to spend much time training people on how to use that technology of which this can lead to project delay.

By adding new people to the project may also cause problems, as those people may not have knowledge about the project. The project manager must be sure from the outset that the project is not given to outside consultants or hardware or software vendors. The project manager must be from one of the major functional areas and have a thorough understanding of the needs and workings of the business, the type of the person who takes charge and who takes responsibility. Outside consultants can make a valuable contribution if are knowledgeable or experienced people.

According to the third interviewee results, the people who are involved in the project should be people who have knowledge about the business operations within the organisation. People from the outside do not have knowledge about the business within the organisation, and this can delay the project because project manager must first explain to them how the organisation operates. If the company need to hire a consultant, they must use that person's broader experience to solve the more strategic issues, to provide education and to identify potential pitfalls before they become disasters.

The results obtained concur with the literature specified in Chapter 2; both suggest that introducing new technology and adding new people can help project managers be successful with system integration (Glass, 1998:30). Therefore, both the interview and literature review saw software runaways remedies as a solution to system integration problems.

#### **4.3.5 What Technical Tools are Needed for Successful System Integration?**

The instruments that yielded the best data to answer this question were the interview and observation. These can be synthesised as follows: Interviewees saw computer aided system engineering as a tool that can be used for system integration success. By introducing, CASE technology, information systems developers can achieve greater system development productivity while providing a new approach to engineering IS reliably. CASE lets system analysts document and model an IS from its initial user requirements through design and implementation.

These results were supported by the findings from the questionnaire that says, CASE tools help in the process of system integration as it provides the analyst or system developer with facilities for drawing a system's architectural diagrams, defining and describing functional and data objects.

The results obtained concur with the literature specified in Chapter 2; both suggest that CASE tools are seen as enablers of system integration success. Computer aided system engineering tools help system developer to identify relationships between system components and providing annotations to aid project management (Bell, 1992:19). The user's various work products are stored in an integrated, non-redundant form in a central repository or dictionary on the workstation or on a central server or host system. The system definition as a whole can be checked for consistency and completeness. Analysis can be performed on the information collected or defined to data, thus supporting incremental development and the detection of inconsistencies and errors early in



the life cycle. There was no opposing results shown on this findings, therefore all interviewees saw computer aided system engineering as the best tool to overcome the difficulty with system integration.

#### **4.3.6 What is the Role of User/client Interaction for System Integration Success?**

The instruments that yielded the best data to answer this question were the interview and observation. These can be synthesised as follows: Interview findings regarded user/client involvement as another solution for system integration problems. User/client interaction is seen as important for system integration success and this can help the system engineers to achieve better system quality if system design is based on the user's need, i.e. this may contribute to the success of system integration and it can also increase user acceptance. To build a system of high quality, the end-user's requests and problems also needs to be effectively handles.

These results were supported by the findings from the questionnaire that says, the user or the client is regarded as very important for system development and should be involved from the onset so that the system to be built will satisfy the user's needs and system developers can also be successful with system integration. It is very much important for system developers, project managers and system engineers to understand the first stage in the life cycle model, which is the "requirements and specification" stage beforehand.

The results obtained concur with the literature specified in Chapter 2; both suggest that the user's involvement increase the likelihood that the resulting system will be satisfactory to the user and his needs, as well as the amount of time necessary to complete the development task (Olson, 1993:37).

Therefore the following are important on system integration success:

- A concentration on finding out exactly what the users of a system really want; the formal specification of the requirements of a system.
- Demonstrating an early version of a system to its customers (prototyping).
- The end-user should also know how they should get involved and what role they should play.

#### 4.4 System Integration Strategy for Success

The client and the corporation should have well-articulated strategy for development and implementation of the system integration programme, so that they can be successful with system integration process (third interviewee). This strategy must be business-oriented, cost-effective and provide the best return to the client for the investment made. It is necessary to know how to proceed with system integration development, from the onset, beginning with requirements specifications for the client and with the proposal response on the part of the corporation.

Table 4.9 Illustrates the guidelines and rules for success when planning, designing and implementing integrated systems, for project managers and team assigned for implementation

<b>Systems developers, systems engineers and systems integrators</b>	<b>Project managers</b>	<b>Description of guidelines for implementing integrated systems</b>
Have a commitment by client and system integration organisation	Assess the total feasibility of the systems integration plan and how it fits into the overall business strategy for the enterprise	Systems developers and system engineers should involve users of the systems and system integrators to build a product of high quality
Evaluate the production and service processes for improvement opportunities, screen all new technologies for relevance and appropriateness	Prepare and define systems integration plans that include technologies, tools, methods and activities for production and service processes	Project managers should explain system integration plans to systems developers and system integrators

<b>Systems developers, systems engineers and systems integrators</b>	<b>Project managers</b>	<b>Description of guidelines for implementing integrated systems</b>
Understand the objectives of the programme and how to measure progress towards these objectives	Have an overall management strategy	Project managers should implement strategy for integrated systems and also has to explain the objectives of the programme to systems developers and systems engineers
Identify all the functional specifications of existing and new systems	Develop a phased implementation plan that addresses key events and activities	Project managers should help systems developers in identifying functional specifications of systems so that they can be successful with system integration
Emphasises preventative solutions, data integrity, quality, reliability, availability, discipline, productivity and cost reduction	Arrange for adequate training of work force on the commissioning and maintenance of the systems and technologies. Provide for personnel preparation, select and train system integrators	Project managers should be responsible for training people to use new technologies. They are also responsible for selecting and training systems integrators
Have a quality assurance strategy in place  Have an action plan for development of an audit trail	Involve all potential users of the system during implementation. Sell the entire system integration plan to unions and employees	Quality assurance strategy is very important as it helps systems developers to check whether the system is of a good quality. User involvement is also important as the product is built for the user
Have a risk assessment and performance evaluation plan	Emphasises total systems solutions through pay for performance, competitive advantage and team work	Project managers should be able to assess risks from the onset so that they can build systems of high quality

## 4.5 Summary

In this study, interviews, observations and questionnaires were used as best instruments to answer research questions in Chapter 1. Interview research revealed that interviewees had differing point of views on some of the options used to address the problems with system integration. The researcher will use the data presented and analysed in this chapter to draw the conclusion and make recommendations for the next chapter.

# Chapter 5

## Conclusion and Recommendations

### 5.1 Introduction

By evaluating the use of Information system engineering (ISE) environment and its options for system integration success, the researcher attempted to investigate the way project managers established Information system engineering (ISE) environment to overcome the difficulty with system integration in companies around Pretoria (Nissan, BMW and Telkom).

### 5.2 Summary of Research

The research problem and proposal are formulated in **Chapter 1**. The purpose and motivation of the study is also discussed.

**Chapter 2** is a literature survey of local and international literature, where the study is placed within the framework of IT system integration. An overview of information system engineering environment and its options, as well as IT system integration itself, is given.

**Chapter 3** gives an explanation of the research problem and the methods and instruments used during the investigation.

In **chapter 4** the results and analysis of the interviews are given. This chapter answers the research questions by answering the sub-questions.

### 5.3 Answers to the Sub-questions

In order to answer the research question stated in Chapter 1 “What is the feasibility of establishing an Information systems environment (ISE) in relation to the causes of system integration difficulties and the options for integration success?” the following questions were identified:

### **5.3.1 Difficulties with System Integration**

Project managers revealed that system integration is indeed a big problem.

They saw problems such as:

- introducing new technology to the project
- poor management
- adding new people to the project
- lack of knowledgeable/ experienced people as factors that lead to system integration failure
- 

### **5.3.2 How to Succeed with System Integration**

Project managers who were subjected to information system engineering environment, indicated the following:

- They saw the establishment of Information system engineering environment as a good remedy for system integration success by applying its tools, methods and techniques.
- They enjoyed the establishment of this alternative environment.

### **5.3.3 What is the Role of Ecosystem Approach for System Integration Success?**

Project managers saw ecosystem approach as a solution to system integration problems only if:

- top management do not own information and do not deny access to relevant information
- knowledge management is practiced within the company whereby people share knowledge about the systems they develop

### **5.3.4 What is the Role of Software Runaways for System Integration Success?**

Project managers indicated that software runaways remedies can overcome system integration problems only if:

- new people added to the project are knowledgeable and experienced people to avoid training
- people do not have fear about new technology that is introduced and it is very easy to them to use that technology

### **5.3.5 Role of User Involvement**

Project managers revealed that:

- it is very important to build the system according to user's requirements.
- they enjoyed involving the system user as he/she is the one who will help them to build a system of high quality

### **5.3.6 The Role of Technical Support for System Integration**

Project managers saw Computer-aided system engineering (CASE) as tools for system integration success.

- They enjoyed and supported the use of CASE tools to overcome the difficulty with system integration

## **5.4 Answer to the research question**

The researcher set the following research question: "What is the feasibility of establishing an Information systems environment (ISE) in relation to the causes of system integration difficulties and the options for integration success?".

The researcher indicated that Information system engineering environment and its options could be effectively used to supplement the traditional ways of integrating systems. Two of the project managers had a positive view of establishing Information system engineering environment for system integration success. The researcher is also of the opinion that, in future, the use of information system engineering environment and its options would alleviate the workload of the system integrators and project managers in most organisations.

## 5.5 Recommendations

As in most evaluation there are shortcomings, in this study the shortcomings can be linked to the following:

- The time spent on interviews and questionnaire was too short. It would have been beneficial if the project managers could have spent more time acquainting themselves with systems development as well as integrating those systems.
- The number of project managers participated in all stages was too small to draw significant conclusions.
- The major limiting factor was the lack of knowledge among project managers in some of the options (ecosystem approach and software runaways remedies) applied for system integration success.

As stated earlier in this study, the target group was too small to draw definite conclusions. However, reviewing the literature relating to information system engineering environment and including objectives of project managers in this study, it is evident that information system engineering environment and its options can be useful tools for system integration success, provided the following problems are addressed:

### 5.5.1 Ecosystem Approach

People know the role of information and also get access to relevant information.

### 5.5.2 Software Runaways Remedies

Outside consultants have knowledge about the business and new technology introduced is user friendly.

### 5.5.3 Life cycle Model

Project managers be sure that all stages in the life cycle model are be followed.

## 5.6 Further Research that needs to be Conducted

The following recommendations can be made for future investigations:

- Investigating the use of information system engineering environment for continuous evaluation.
- Introducing Computer integrated manufacturing environment in South African companies.
- To determine the effect of ecosystem approach where systems developers have unlimited access to information and where knowledge is shared.
- Project managers stress the importance of following all steps and phases in the life cycle model for system integration success.



## References

- Aslaksen, E. & Belcher, R. 1992. *System engineering*. New York: Prentice Hall.
- Babbie, E. 1992. *The practice of social research*. California: Wadsworth.
- Bell, D et al. 1992. *Software Engineering: a programming approach*. New York: Prentice Hall.
- Bell, J. 1993. *Doing your Research Project : A guide for First-Time Researchers in Education and Social science*. Philadelphia: Open University Press.
- Blanchard, B.S. 1991. *System Engineering Management*. New York: Wiley.
- Britton, C. & Doake, J. 1993. *Software System Development : A gentle introduction*. New York: McGraw-Hill International.
- Carey, M.J. 1988. *Human factors in Management Information Systems*. Ablex Publishing: USA.
- Clement, A. 1992. *Computing at Work : Empowering Action by Low Level Users*. New York: John Wiley & Sons.
- Chikofsky, E. 1993. *Computer-Aided Software Engineering (CASE)*. Washington: IEEE Computer Society Press.
- Concise Oxford Dictionary*. 1990. Clarendon Press: Oxford.
- Dauids F.D. 1993. User acceptance of Information technology: System characteristics, user perceptions and behavioural impacts. *International Journal of Man-Machine Studies*, vol. 38, 1993.

- Ford, N.J. & Woodroffe, M. n.d. *Introducing Software Engineering*. New York: Prentice Hall.
- Glass, R.L. 1998. *Software Runaway: Lessons learned from massive software project failures*. United States of America: Prentice Hall.
- Grady, J.O. 1993. *Systems Requirements Analysis*. New York: McGraw-Hill.
- Healy, J.F. 1993 *Statistics: A tool for Social Research*. 3<sup>rd</sup> Ed. California: Wadsworth Publishing Company.
- Human Sciences Research Council 1995. *Ways of seeing the national qualifications framework*. September 1995.
- Jackson, M. 1995. *Software Requirements and Specifications*. England: Addison Wesley.
- Kincheloe, J.L. 1991. *Teachers as Researchers: Qualitative inquiry as a path to Empowerment*. (In: The Falner Press: London).
- Merriam-Webster Online Dictionary. USA.
- Mouton, J & Marais, H. C. 1993. *Basic concepts in methodology of the social sciences*. HRSC series in Methodology. Human Sciences Research Council.
- Olson, J. 1996. *Business success and information technology*. UK: Prentice Hall.
- Reilly, N.B. 1993. *Successful Systems Engineering for Engineers and Managers*. New York: Van Nostrand-Reinhold.

Sage, A. P. & Rouse, W.B. 1999. *Handbook of System Engineering and Management*. New York: John Wiley & Sons Inc.

Zwass, V. 1992. *Management Information Systems*. Brown Publishers: Dubuque.