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THE ORGANISATIONAL PERFORMANCE IMPACT OF ERP SYSTEMS ON SELECTED MANUFACTURING COMPANIES WITHIN SOUTH AFRICA

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A dissertation submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg, in fulfillment of the requirements for the degree of Master of Science in Engineering

Johannesburg, 2010

DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted to the degree of Master of Science in Industrial Engineering to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

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ABSTRACT

Preliminary investigation indicated that there is a need to determine the performance benefits that South African manufacturing firms are gaining from Enterprise Resource Planning (ERP) systems. Clarification on the factors contributing to ERP success is also required. Consequently the central research problem is:

To determine the impact of ERP systems on organisational performance, by analysing achieved ERP benefits within the framework of a suitable Performance Measurement System (PMS), and to investigate an association between Critical Success Factors (CSF) and ERP benefits.

By conducting a literature review a list of expected ERP benefits and CSFs is compiled. PMSs are evaluated and an appropriate model is designed for the purpose of ERP impact evaluation. The identified ERP benefits and CSFs are refined by means of a series of structured interview sessions with local ERP experts. The results of the interview sessions are built into a questionnaire, which is used in a survey within the South African manufacturing sector.

The results of the study indicate that business benefits are being realised by manufacturing companies who have implemented ERP systems. By building these benefits into the chosen performance measurement model it is shown that these benefits have a positive impact on organisational performance. Although a core list of CSFs is identified, and three associations are proposed between CSFs and ERP benefits, further research is suggested to validate these findings.

DEDICATION

For any good in this to God be the glory.

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Firstly, thanks go to my research supervisor, Prof. D.R. Snaddon, for the inspiration and words of wisdom he provided throughout the duration of this research. It is due to his patience, guidance and encouragement that this research was able to stay on course when I began to wander off into uncharted territory.

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Finally, thanks go to the business professionals who gave of their knowledge and time to partake in the interview sessions and market research. Without their willingness to share their experiences and ERP expertise this research would not have been possible.

TABLE OF CONTENTS

DECLARATION ..... **I**

ABSTRACT ..... **II**

DEDICATION ..... **III**

ACKNOWLEDGEMENTS ..... **IV**

TABLE OF CONTENTS ..... **V**

LIST OF TABLES ..... **X**

LIST OF FIGURES ..... **XIII**

LIST OF SYMBOLS ..... **XIV**

LIST OF ABBREVIATIONS ..... **XV**

DEFINITION OF TERMS ..... **XVI**

1 INTRODUCTION **1**

1.1 RESEARCH CONTEXT 1

1.2 BACKGROUND TO THE RESEARCH 1

1.2.1 Enterprise resource planning systems *1*

1.2.2 Benefits of ERP systems *2*

1.2.3 Organisational and ERP performance measurement *3*

1.2.4 Reasons for ERP successes and failures *3*

1.2.5 Summary of the preliminary review *3*

1.3 PURPOSE OF THE RESEARCH 4

1.4 STATEMENT OF THE PROBLEM 5

1.5 RESEARCH OBJECTIVES 5

1.6 DELIMITATIONS 9

1.7 IMPORTANCE OF THE STUDY 9

1.8 ASSUMPTIONS 10

1.9 ORGANISATION OF THIS REPORT 11

2 LITERATURE REVIEW **14**

2.1 BENEFITS OF ERP SYSTEMS 16

2.1.1 Defining ERP systems and benefits *16*
2.1.2 Motivation for adopting ERP systems *17*
2.1.3 Expected benefits of ERP systems *17*
2.1.4 Realisation of expected benefits *18*
2.1.5 Rationalisation of ERP benefits *19*
2.1.6 Summary of ERP benefits *21*
2.2 ORGANISATIONAL AND ERP PERFORMANCE MEASUREMENT 23
2.2.1 Defining performance measurement *23*
2.2.2 Organisational performance measurement systems *24*
2.2.3 ERP performance measurement systems *33*
2.2.4 Link between ERP and organisational performance measurement systems *35*
2.2.5 Evaluation of ERP performance measurement systems *38*
2.2.6 Selection of an ERP PMS *42*
2.2.7 Application of the ERP Time-Based BSC *48*
2.2.8 Summary of organisational and ERP performance measurement *49*
2.3 CRITICAL SUCCESS FACTORS FOR A SUCCESSFUL IMPLEMENTATION 51
2.3.1 Defining ERP implementation success *51*
2.3.2 Identified critical success factors *52*
2.3.3 Summary of CSFs *58*
2.4 SUMMARY OF THE LITERATURE REVIEW RESULTS AND FINDINGS 59
3 METHODOLOGY 61
3.1 LITERATURE REVIEW FINDINGS 62
3.2 RESEARCH PROBLEM 65
3.3 RESEARCH OBJECTIVES AND HYPOTHESES 65
3.4 HIGH LEVEL RESEARCH METHODOLOGY 68
3.4.1 Methodology for investigating Objective 1 ..... *69*
3.4.2 Methodology for investigating Objective 2 ..... *70*
3.4.3 Methodology for investigating Objective 3 ..... *70*
3.4.4 Methodology for investigating Objective 4 ..... *71*
3.5 VALIDITY AND RELIABILITY 72
3.5.1 Validity of the chosen method *72*

3.5.2 Validity of measurement instruments ... *73*
3.5.3 Reliability of measurement instruments ... *75*
3.6 Cronbach's Alpha ... 76
3.7 Hypothesis Testing and Statistical Significance ... 77
3.8 Linear Regression ... 77
3.9 Sampling Frame for Phase 1 ... 79
3.10 Population and Sample Size for Phase 1 ... 80
3.11 Sampling Frame for Phase 2 ... 80
3.12 Population and Sample Size for Phase 2 ... 81
3.13 Data Collection and Assessment ... 84
3.14 Assumptions ... 85
3.15 Summary of Methodology ... 86
4 METHODOLOGY & RESULTS: STRUCTURED INTERVIEWS ... 87
4.1 Objectives of the Structured Interviews ... 88
4.2 Interview Methodology ... 88
4.2.1 Data collection methodology ... *89*
4.2.2 Data assessment methodology ... *92*
4.2.3 Results analysis methodology ... *95*
4.3 Interview Results ... 97
4.3.1 Interview response ... *97*
4.3.2 Nature of the data ... *98*
4.3.3 Descriptive statistics ... *99*
4.3.4 Application of descriptive statistics ... *102*
4.4 Discussion of the Interview Results ... 104
4.4.1 ERP benefits data analysis and interpretation ... *104*
4.4.2 CSF data analysis and interpretation ... *111*
4.5 Summary of Structured Interviews Results and Findings ... 113
5 METHODOLOGY & RESULTS: MARKET RESEARCH ... 115
5.1 Objectives of the Market Research ... 115
5.2 Market Research Methodology ... 116
5.2.1 Data collection methodology ... *117*

5.2.2 Data assessment methodology *122*
5.3 MARKET RESEARCH RESULTS 131
5.3.1 Survey response *131*
5.3.2 Data consolidation *133*
5.3.3 Background factors and sources of bias *137*
5.3.4 Nature of the data *148*
5.3.5 Application of descriptive and inferential statistics *148*
5.4 SUMMARY OF MARKET RESEARCH RESULTS & FINDINGS 175
6 DISCUSSION OF RESULTS 177
6.1 BACKGROUND SOURCES OF BIAS 177
6.1.1 Respondent's position in the organisation *177*
6.1.2 Organisation reporting level *178*
6.1.3 Annual revenue *178*
6.1.4 Industry segmentation *178*
6.1.5 Primary manufacturing process *179*
6.1.6 Enabling systems in place *179*
6.1.7 Brand of ERP system implemented *179*
6.1.8 Year of "go-live" *179*
6.1.9 Number of legacy systems in place *180*
6.1.10 Prior ERP system in place *180*
6.2 DISCUSSION OF METHODOLOGY EMPLOYED 181
6.3 BENEFITS FROM ERP SYSTEMS 183
6.3.1 Addressing Part 1 ..... *184*
6.3.2 Addressing Part 2 ..... *184*
6.4 VALIDITY AND RELIABILITY OF THE ERP TIME-BASED BSC 187
6.5 IMPACT OF ERP SYSTEMS ON ORGANISATIONAL PERFORMANCE 190
6.6 CSFS FOR A SUCCESSFUL ERP IMPLEMENTATION 193
6.7 SUMMARY OF DISCUSSION OF RESULTS 196
7 CONCLUSION 197
7.1 RESEARCH OVERVIEW 197
7.2 HYPOTHESES TESTING 198

7.2.1 Objective 1 198
7.2.2 Objective 2 199
7.2.3 Objective 3 199
7.2.4 Objective 4 200
7.3 STUDY LIMITATIONS 201
7.4 SUMMARY OF CONCLUSIONS 202
8 RECOMMENDATIONS FOR FURTHER RESEARCH 204
REFERENCES 206
APPENDIX A: MARKET RESEARCH POPULATION AND SAMPLE SET 216
APPENDIX B: STRUCTURED INTERVIEW QUESTIONNAIRE DESIGN 229
APPENDIX C: ABC CLASSIFICATION 238
APPENDIX D: STRUCTURED INTERVIEW TRANSCRIPTS 241
APPENDIX E: CONSOLIDATED INTERVIEW RESPONSES 272
APPENDIX F: MARKET RESEARCH QUESTIONNAIRE DESIGN 284
APPENDIX G: SAMPLE CALCULATIONS 305
APPENDIX H: PASW ANALYSIS OUTPUT 313

LIST OF TABLES

Table 2.1 Expected ERP benefits 21
Table 2.2 Proposed ES benefits framework 34
Table 2.3 ERP scorecard 38
Table 2.4 ERP PMS evaluation 42
Table 2.5 ERP Time-Based BSC 43
Table 2.6 Strategic links in the ERP Time-Based BSC 47
Table 2.7 Critical success factors 52
Table 3.1 Goodness of fit guide 79
Table 4.1 Interview respondents 97
Table 4.2 Structured interview descriptive statistics 101
Table 4.3 Application of descriptive statistics to ERP benefits data 102
Table 4.4 Application of descriptive statistics to CSF data 103
Table 4.5 ABC analysis of benefits 104
Table 4.6 CSF analysis 111
Table 4.7 CSF categories 111
Table 4.8: ERP benefits and CSFs for further investigation 114
Table 5.1 Strength of association 128
Table 5.2 Goodness of fit guide 130
Table 5.3 Consolidated survey responses 134
Table 5.4 Benefit averages and confidence intervals 149
Table 5.5 Ordered benefits 149
Table 5.6 Sample item analysis output from PASW 156
Table 5.7 Internal consistency reliability summary 159
Table 5.8 Consolidated item-total statistics 160
Table 5.9 Perspective averages and confidence intervals 162
Table 5.10 CSF descriptive statistics 165
Table 5.11 Regression equations – "year 1" 166
Table 5.12 Significance test (p-value) – "year 1" 167
Table 5.13 Coefficient of determination (R^2) – "year 1" 167
Table 5.14 Regression equations – "year 2" 168
Table 5.15 Significance test (p-value) – "year 2" 169

Table 5.16 Coefficient of determination (R^2) – "year 2" 169
Table 5.17 Regression equations – "year 3" 170
Table 5.18 Significance test (p-value) – "year 3" 171
Table 5.19 Coefficient of determination (R^2) – "year 3" 171
Table 5.20 Regression analysis summary table – "year 1" 172
Table 5.21 Regression analysis summary table – "year 2" 172
Table 5.22 Regression analysis summary table – "year 3" 172
Table 6.1 Background sources of bias 177
Table 6.2 Consolidated benefits results 183
Table A1 Top 200 JSE listed companies 217
Table A2 SA manufacturing firms with revenue >R300 million pa 225
Table A3 Market research sample set 226
Table C1 ABC classification of central tendency 238
Table C2 ABC classification of skewness 239
Table C3 ABC classification of variability 239
Table C4 Final ERP benefits interview classification 240
Table C5 Overall ABC classification 240
Table D1 Interview participants 241
Table E1 Structured interview participants 272
Table E2 Participant comments on ERP benefits 273
Table E3 Participant identified additional benefits 282
Table E4 Participant identified additional CSFs 283
Table E5 General participant comments 283
Table G1 Standard normal distribution function 306
Table G2 Benefits calculation data ("year 1") 308
Table G3 t distribution table 308
Table G4 Sample survey data ("year 1") 309
Table H1 PASW output – financial perspective ("year 1") 313
Table H2 PASW output – financial perspective ("year 2") 313
Table H3 PASW output – financial perspective ("year 3") 314
Table H4 PASW output – internal business perspective ("year 1") 314
Table H5 PASW output – internal business perspective ("year 2") 315

Table H6 PASW output – internal business perspective (“year 3”) 315
Table H7 PASW output – customer perspective (“year 1”) 316
Table H8 PASW output – customer perspective (“year 2”) 316
Table H9 PASW output – customer perspective (“year 3”) 317
Table H10 PASW output – learning & growth perspective (“year 1”)..... 317
Table H11 PASW output – learning & growth perspective (“year 2”)..... 318
Table H12 PASW output – learning & growth perspective (“year 3”)..... 318
Table H13 PASW output – ERP Time-Based BSC (“year 1”) – perspective averages..... 319
Table H14 PASW output – ERP Time-Based BSC (“year 2”) – perspective averages..... 319
Table H15 PASW output – ERP Time-Based BSC (“year 3”) – perspective averages..... 320
Table H16 PASW output – ERP Time-Based BSC (“year 1”) – individual items 321
Table H17 PASW output – ERP Time-Based BSC (“year 2”) – individual items 322
Table H18 PASW output – ERP Time-Based BSC (“year 3”) – individual items 323

LIST OF FIGURES

Figure 1.1 Objectives of the research 6
Figure 1.2 Research summary 13
Figure 2.1 Literature review summary 15
Figure 2.2 The performance pyramid 26
Figure 2.3 Performance measurement matrix 28
Figure 2.4 The balanced scorecard 29
Figure 2.5 Integrated dynamic performance measurement system 31
Figure 2.6 Perceived net benefit flow graphs 34
Figure 2.7 Simplified framework for evaluating effects on IT investment 35
Figure 2.8 Typical ERP learning progress curve 44
Figure 2.9 Example of an IS S-curve 45
Figure 2.10 ERP strategy cause-and-effect tree 46
Figure 3.1 Research methodology 61
Figure 3.2 Objectives of the research 65
Figure 4.1 Research methodology (Phase 1) 88
Figure 4.2 Skewness of interview responses 98
Figure 5.1 Research methodology – market research 116
Figure 5.2 Latent variables to be tested using Cronbach's α 125
Figure 5.3 Timing of returned questionnaires 131
Figure 5.4 Positions held by respondents 138
Figure 5.5 Organisation level reported on 139
Figure 5.6 Annual revenue 140
Figure 5.7 Industry segmentation 141
Figure 5.8 Manufacturing process 142
Figure 5.9 Enabling systems in place 143
Figure 5.10 ERP system implemented 144
Figure 5.11 Year of "go-live" 145
Figure 5.12 Number of legacy systems in place 146
Figure 5.13 Previous ERP system in place 147
Figure 5.14 Financial benefits PNBF graphs 150
Figure 5.15 Internal business benefits PNBF graphs (part 1) 151

Figure 5.16 Internal business benefits PNBF graphs (part 2) 152
Figure 5.17 Customer benefits PNBF graphs 152
Figure 5.18 Learning & growth PNBF graphs 153
Figure 5.19 ERP Time-Based BSC PNBF graphs 163
Figure 6.1 Integration of applications 185
Figure 6.2 IT operating costs 185
Figure 6.3 Organisational performance impact 191
Figure 7.1 Research summary 203
Figure B1: Draft interview questionnaire 233
Figure B2: Final interview questionnaire design 237
Figure F1 Survey participant information 286
Figure F2 ERP survey questions 288
Figure F3 Survey definitions 289
Figure F4: Survey covering letter 294
Figure F5: Reminder letter 296
Figure F6 Final reminder letter 297
Figure F7 Final ERP survey questions worksheet 303
Figure F8 Final ERP survey definitions worksheet 304

LIST OF SYMBOLS

Arithmetic mean	$\bar{x}$
Coefficient of determination	R^2
Correlation coefficient	r
Cronbach's alpha	α
Fisher's skewness	G
Number of variables	N
Pearson's skewness	Sk
Standard deviation	σ
Weighted mean	$\bar{\bar{x}}$

LIST OF ABBREVIATIONS

AHP	Analytical Hierarchy Process
APO	Advanced Planning and Optimisation
APS	Advanced Planning and Scheduling
BI	Business Intelligence
BOS	Business Operating System
BPR	Business Process Reengineering
BSC	Balanced Scorecard
CIM	Computer Integrated Manufacturing
CIO	Chief Information Officer
CRM	Customer Relationship Management
CSF	Critical Success Factor
DV	Dependent Variable
ERP	Enterprise Resource Planning
ES	Enterprise System
FMS	Flexible Manufacturing Systems
IDPMS	Integrated Dynamic Performance Measurement System
IS	Information System
IT	Information Technology
IV	Independent Variable
JDE	J.D. Edwards
JIT	Just-In-Time
JSE	Johannesburg Stock Exchange
KPI	Key Performance Indicator
LAN	Local Area Network
LV	Latent Variable
MES	Manufacturing Enterprise System
MRP	Material Requirements Planning
MRPII	Manufacturing Resource Planning
MS	Microsoft
MVFCT	Modified Value Focused Cycle Time
OPT	Optimised Production Technology

OT	On Time
OTIF	On Time In Full
PASW	Predictive Analytics Software
PMM	Performance Measurement Matrix
PMQ	Performance Measurement Questionnaire
PMS	Performance Measurement System
PNBF	Perceived Net Benefit Flow
QA	Quality Assurance
SA	South Africa
SCM	Supply Chain Management
SCOR	Supply Chain Councils Operation Reference
SLA	Service Level Agreement
SOP	Standard Operating Process
S&OP	Sales and Operations Planning
SMART	Strategic Management And Reporting Technique
SPSS	Statistical Package for the Social Sciences
SRM	Supplier Relationship Management
TQM	Total Quality Management
WIP	Work In Progress

DEFINITION OF TERMS

Business Process Reengineering: A business process is a set of logically related business tasks performed to achieve a defined business outcome. "Reengineering" refers to the fundamental rethinking and redesign of an existing business process with the aim of improving the process flow and desired outcome.

Critical Success Factor: any attribute deemed instrumental in achieving a successful implementation.

ERP System: An ERP system is a packaged business software system that enables a company to manage the efficient and effective use of resources (materials,

human resources, finance, etc) by providing a total, integrated solution for the organisation's information-processing needs (Nah et al, 2001, p285).

ERP benefit: a favourable effect on a performance measure.

"Go-live": the period during which a company begins to operate on an ERP system, using the system inputs and outputs to manage and control business activities.

Implementation: Implementation refers to the planning, set-up, "go-live" and post "go-live" phases of an ERP installation (Harwood, 2003).

Manufacturing company: a company that adopts a production (or extraction) process to transform a physical raw material (or part assembled item) into a product for sale to the public, or for further processing. Mining and power generation companies are included in this category for the purpose of this study.

Organisational performance measurement: the process of quantifying the efficiency and effectiveness of actions within an organisation, using an appropriate set of metrics (adapted from Neely et al, 1996, p424).

Performance measure: a metric used to quantify the efficiency and/or effectiveness of action (Neely et al, 1996, p424).

Performance measurement system: the set of metrics used to quantify the efficiency and effectiveness of actions (Neely et al, 1996, p424).

1 INTRODUCTION

1.1 Research Context

Having been involvement with a number of Enterprise Resource Planning (ERP) and enabling system implementations, the researcher identified what appeared to be a shortfall in the local ERP knowledge base. Preliminary research showed there to be a lack of information available regarding the impact that ERP systems are having on South African organisations. Further research revealed that this lack of information extended (but to lesser degree) to the international community. The review also showed that, not only is there a lack of information regarding the benefits of ERP systems, but the factors responsible for potential benefits are still being debated.

1.2 Background to the Research

This section summarises the initial literature review that was conducted. The literature provides an overview of the evolution of ERP systems before focusing on the ERP aspects central to this research.

1.2.1 Enterprise resource planning systems

The ERP systems available today began to evolve in the 1960's when customized software packages focusing on inventory control were introduced to manufacturing organizations. During the 1970's the focus shifted to developing information systems to plan and control manufacturing. These systems, known as Material Requirements Planning (MRP) systems, played an important role in translating the master production schedule, built for end items, into time phased net requirements for sub-assemblies, components, raw materials and procurement (Gupta and Kohli, 2004, p3). The 1980's saw the evolution of MRP systems into Manufacturing Resource Planning (MRPII) systems. MRPII systems combined MRP outputs with routing information to determine capacity requirements, thus serving as a control loop to ensure that MRP plans were feasible. As information systems developed across other functional areas the need to integrate these

systems with MRPII became apparent. In the 1990's the Gartner Group coined the term "Enterprise Resource Planning" to describe the next generation MRPII systems that integrated software applications beyond manufacturing to other functional areas, such as finance and human resources, resulting in a company wide information system (Dahlen and Elfsson, 1999; Kumar et al, 2003, p794). An ERP system can be defined as follows:

"An ERP system is a packaged business software system that enables a company to manage the efficient and effective use of resources (materials, human resources, finance, etc) by providing a total, integrated solution for the organisation's information-processing needs" (Nah et al, 2001, p285).

In the 2000's ERP systems continue to develop, and by incorporating technology such as the internet are now being designed to aid organizations in integrating functions across their supply chains.

1.2.2 Benefits of ERP systems

Companies worldwide have been adopting ERP systems based on the expectation of obtaining the tangible and intangible benefits of cost reductions and revenue improvements, including (but not limited to) inventory and personnel reduction, productivity and order management improvement, improved information availability, improved processes, and improve customer service (Poston and Grabski, 2001, p273). Whilst there is much literature supporting these ERP benefits and sighting examples of successful implementations (for example, Poston and Grabski, 2001; Spathis and Constantinides, 2003; Gupta and Kohli, 2004), there are also many cases where such benefits have failed to be realized (for example, Al-Mashari and Zairi, 2000; Sarkis and Sundarraj, 2000). These mixed results are an indication that further research is needed in this field and the reasons for certain implementations producing greater benefits than others needs to be clarified.

1.2.3 Organisational and ERP performance measurement

The bulk of the current research on relating ERP benefits to organisation performance focuses solely on the financial impacts of these systems (Poston and Grabski, 2001; Hunton et al, 2003; Hendricks et al, 2007). The main criticism of this method is that it not only focuses on one aspect of organisational performance but often the researcher is left making assumptions about the association between published financial results and the introduction of the ERP systems (Shang and Seddon, 2002, p214). Consequently a number of researchers are moving away from purely financial ERP assessments and are focusing on other areas of organisational performance (for example, operational measures) that are being impacted by ERP systems.

1.2.4 Reasons for ERP successes and failures

Due to the high failure rate of ERP implementations there is a need for a better understanding of the Critical Success Factors (CSFs) that determine an effective implementation (Nah et al, 2001, p286). In addressing this need much of the recent research has focused on adopting a case study approach to investigate the causes of ERP successes and failure (for example, Al-Mashari and Zairi, 2000; Al-Mashari and Al-Mudimigh, 2003; Kumar, Maheshwari and Kumar, 2003). However, as this is a relatively new field of study, and the lessons and CSFs that have been documented vary, further evidence is needed to confirm and build on the current knowledge base.

1.2.5 Summary of the preliminary review

The above literature review raised the following concerns:

1. Although many studies have examined the benefits of ERP systems, there have been mixed findings on the ability of implementing firms to realise these benefits.
2. Of the ERP Performance Measurement Systems (PMS) reviewed, there appeared to be consensus that ERP benefits need to be incorporated as an input to measure the impact on organisational performance. However no

consensus was found on the optimal PMS, or evaluation methodology, to adopt.

3. Although many case studies have been conducted on ERP CSFs, it was highlighted that further research is needed in this field. In particular the literature was found to be weak when it comes to linking CSFs to benefits achieved.
4. The review revealed that the majority of this ERP research has been conducted utilizing North American, European or Asian examples, whilst the research in a South African (SA) context is sparse.

1.3 Purpose of the Research

To address the above concerns, this study aims to build on the ERP literature by investigating how ERP systems affect organisational performance over time, within the manufacturing sector of South Africa. The primary question that this research aims to address is:

Do ERP systems have a positive impact on organisational performance in the time periods following implementation?

To investigate this problem a link needs to be established between ERP systems and organisational performance. This leads to the question:

Is there a valid and reliable PMS that links ERP performance to organisational performance?

A review of the ERP literature revealed that the most likely influence on organisational performance would be through the expected ERP benefits, and the identified PMS would contain reference to these benefits. Therefore, the third question to be investigated is:

What are the benefits gained from ERP systems?

By investigating these three questions the research aims to establish the impact of ERP systems on organisation performance. However, it is felt that the without investigating the factors responsible for this impact the research would be incomplete. Therefore, the fourth research question is:

What are the CSFs associated with ERP benefits being achieved?

1.4 Statement of the Problem

The literature review (Chapter 2) enabled the questions behind the purpose of the research to be partially answered. However, further research is required to address all four questions. Combining the outstanding questions leads to the research problem for this study:

To determine the impact of ERP systems on organisational performance, by analysing achieved ERP benefits within the framework of a suitable PMS, and to investigate an association between CSFs and ERP benefits.

1.5 Research Objectives

After conducting a detailed literature review (Chapter 2), based on the questions raised through section 1.3, the central research problem is broken down into its sub-problems, and four objectives are defined for the research. These objectives are defined in line with the sequence in which the research questions need to be investigated in addressing the central research problem.

The purpose and objectives of the research are summarised in Figure 1.1.

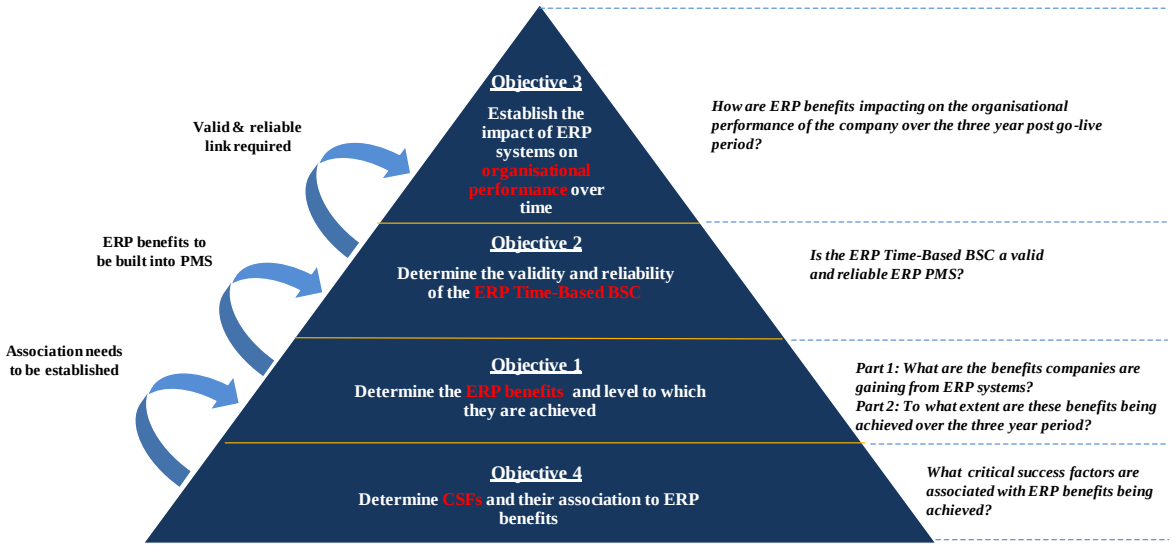


Figure 1.1 Objectives of the research

Firstly, ERP benefits are investigated to establish a comprehensive list of expected benefits and to determine the level at which local companies are achieving these benefits. The first objective is defined as:

Objective 1: To determine the benefits that SA manufacturing companies are gaining as the result of implementing ERP systems, and to gauge the level at which the benefits are being achieved.

Objective 1 is investigated through **Sub-Problem I**:
Part 1: What are the benefits that manufacturing companies are gaining as a result of implementing ERP systems?
Part 2: To what extent are benefits being achieved over the three year post "go-live" period?

The adopted hypothesis for this problem is **Research Hypothesis I**:
South African manufacturing firms are experiencing business benefits as a result of ERP implementations.

The second step is to determine the validity and reliability of the ERP Time-Based BSC for the purpose of evaluating the impact of ERP systems on organisational performance:

Objective 2: To determine the validity and reliability of the chosen ERP performance measurement system.
(Refer to section 3.5 for description of "validity and reliability".)

Objective 2 is investigated through **Sub-Problem II**:
Is the ERP Time-Based BSC a valid and reliable ERP PMS?

The adopted hypothesis for this problem is **Research Hypothesis II**:
The ERP Time-Based BSC is a valid and reliable ERP PMS.

Having confirmed the validity of the list of ERP benefits, and hence the content validity of the ERP Time-Based BSC, the BSC structure can be populated with the ERP benefits data. Once the reliability of the ERP Time-Based BSC has been confirmed the primary research question can be investigated via Objective 3:

Objective 3: To evaluate the impact of ERP systems on organisational performance over time (taken to be the three year period post "go-live")

Objective 3 is investigated through **Sub-Problem III**:
How are ERP benefits impacting on the organisational performance of the company over the three year post "go-live" period?

The adopted hypothesis for this problem is **Research Hypothesis III**:
The benefits gained through ERP implementations have a positive impact on organisational performance over the three year post "go-live" period.

Through Objectives 1 to 3 the research aims to establish the impact of ERP systems on organisational performance, however the factors responsible for this impact still need to be determined. These factors are investigated by addressing Objective 4:

Objective 4: To determine the Critical Success Factors required for a successful implementation through their association with ERP benefits being achieved.

Objective 4 is investigated through **Sub-Problem IV**:
What CSFs can be associated with ERP benefits being achieved?

The adopted hypothesis for this problem is **Research Hypothesis IV**:
Common CSFs are associated with ERP benefits, and hence an increase in organisational performance, being achieved.

1.6 Delimitations

The research is conducted within the following framework:

1. The scope of the study is limited to the manufacturing sector within South Africa, however the literature review is global.
2. The study is not limited to a single ERP system, but aims to incorporate all main stream ERP systems (for example, SAP, Oracle, JD Edwards and PeopleSoft). However, as the study does not want to confuse the performance of these established ERP systems with smaller, often customer built systems, only organisations with an annual turnover of >R300 million are investigated (this threshold was established based on a review of the Financial Mail's Top 200 list (Financial Mail, 2008) and the perceived IT purchasing power of organisations outside of this list, i.e. revenue below R300 million per annum).
3. This study does not attempt to establish the level of ERP benefits being achieved at all SA manufacturing firms, but rather aims to establish benefits using a sample of selected firms.
4. The research is not limited to a particular industry within the manufacturing sector, but attempts to cover a range of industries within this sector.

1.7 Importance of the Study

The importance of the study is highlighted through the value it has the potential to add to the ERP community:

1. It promises to benefit manufacturing companies who have implemented ERP systems, by providing them with a means to benchmark their implementations and determine where to focus optimisation initiatives.
2. There is a need for research in this field from both an international, and specifically a South African context. By building on the body of academic knowledge in the ERP field, this research helps to address this need and add to the base of knowledge for use in future research.

3. The research results can be used by consultants and managers tasked with performing opportunity assessments in the ERP and business systems domain.
4. The research can be used as a guide by manufacturing companies considering ERP implementations, when deciding on an implementation strategy and ERP evaluation methods.
5. The research tests the applicability of the Balanced Scorecard framework for ERP performance evaluation.

1.8 Assumptions

The first assumption is that because the ERP systems from the main stream software vendors (namely, SAP, Oracle, PeopleSoft and JD Edwards) have a feature overlap of approximately 60-70% (Gupta and Kohli, 2004, p3) and aim to achieve common business benefits, the research findings are by enlarge independent of the brand of ERP system implemented.

The second assumption is that only a limited number of companies with an annual revenue of <R300 million will be able to invest in a main stream ERP system, and therefore excluding such companies will not bias the results.

The third assumption is that results can be combined across industries within the manufacturing sector.

The fourth assumption is that sample feedback obtained will be applicable to the whole of the SA manufacturing sector.

The fifth assumption is that the demand for ERP implementations and improvement initiatives will continue over the years to come, validating the reasons for this study.

The sixth assumption is that the total population for the market research consists of approximately 160 companies.

1.9 Organisation of this Report

The report is broken down into eight chapters:

Chapter 1 (Introduction) outlines the background to the research, building up to the purpose for the research. The problem statement and the objectives for the research are discussed to address the primary research question. The overall research setting for this study is presented.

Chapter 2 (Literature Review) includes a review of recent studies on ERP systems to determine the status of the current body of knowledge. The outcomes of the literature review include a detailed list of ERP benefits and CSFs which are investigated further through the structured interviews. The findings surrounding ERP performance measurement are used to develop the framework for the measurement model adopted to evaluate the impact of ERP systems within this study.

Chapter 3 (Methodology) discusses the research approach used to investigate the research problem and test the four hypotheses. This section reviews the methods adopted by previous researchers to select the most appropriate approach for this study. It provides a description of the two phases of the research (structured interviews and market research) that have been selected to investigate the four objectives.

Chapter 4 (Structured Interviews) describes the face-to-face interviews that were conducted with local professionals to validate the international research compiled through the literature review. The output from this section is a validated list of ERP benefits and CSFs that are applicable to the SA manufacturing sector.

Chapter 5 (Market Research) describes how the findings from the preceding two chapters are used to compile a questionnaire that was sent to manufacturing companies with ERP systems in place. The results of the market research are analysed in relation to the four objectives.

Chapter 6 (Discussion of Results) discusses the results of the market research in relation to the four research objectives. Through the discussion, the survey results are compared to the literature findings and interview expectations enabling conclusions to be drawn in Chapter 7.

Chapter 7 (Conclusions) summarises the research process followed and the results obtained. It summarises the research findings in relation to the four objectives and draws conclusions surrounding the four research hypotheses.

Chapter 8 (Recommendations for Further Research) lists the areas that need to be investigated to build on the findings of this research and add to the knowledge base of ERP systems and organisational performance impact.

The References section contains details of the books, journal articles and internet addresses that are cited in this report.

The appendices provide details of:

a) The market research population and sample set.
b) The structured interview questionnaire design (including pilot study).
c) The "ABC" process by which ERP benefits are classified in this study.
d) The structured interview transcripts.
e) The consolidated interview responses.
e) The survey questionnaire design (including pilot study).
f) Sample Calculations.
g) PASW analysis output.

The research is summarised in Figure 1.2.

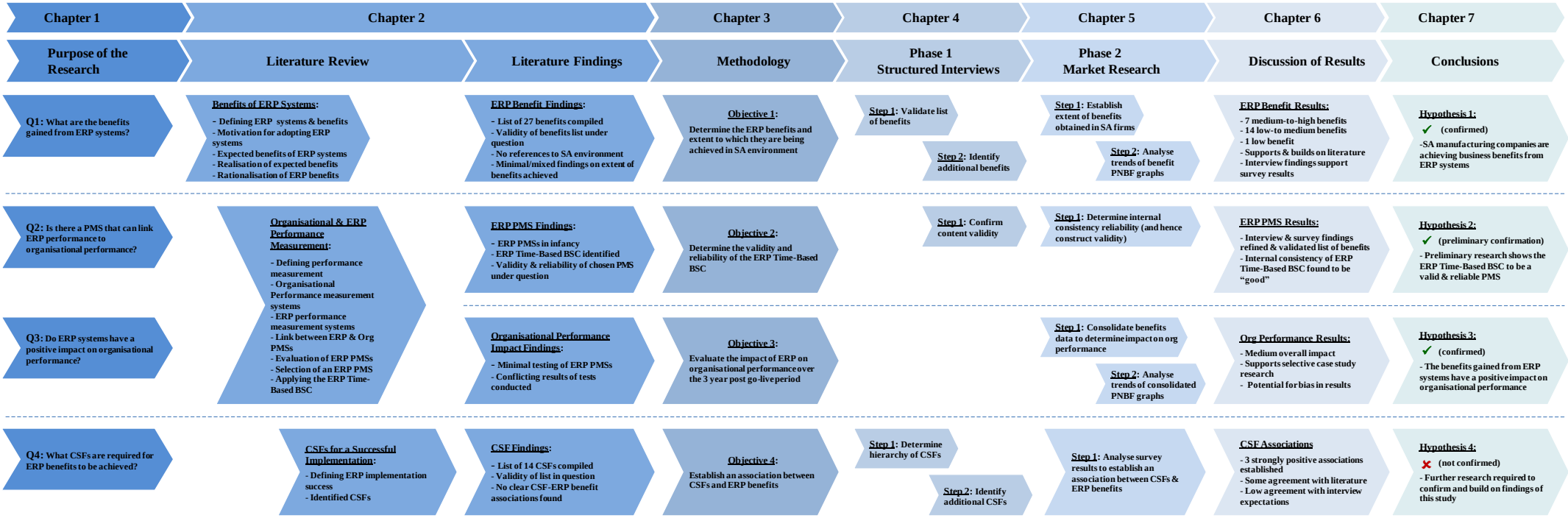


Figure 1.2 Research summary

2 LITERATURE REVIEW

The literature review investigates the questions raised through section 1.3 (Purpose of the research) to determine the status on the current body of ERP knowledge and to gain clarity on the objectives required for this research. Four key questions are asked when describing the purpose of the research:

1. Do ERP systems have a positive impact on organisational performance in the time periods following implementation?
2. Is there a valid and reliable PMS that links ERP performance to organisational performance?
3. What are the benefits gained from ERP systems?
4. What are the CSFs associated with ERP benefits being achieved?

To explore these questions, the literature review starts off by investigating the area that is expected the have the greatest impact on organisational performance, i.e. ERP benefits. It then reviews organisational performance measurement systems as well as the methods used to evaluate ERP performance. Within this section the findings of previous research on ERP performance impact are reviewed. Finally, the literature review investigates the CSFs responsible for ERP benefits being achieved (and by association organisational performance being improved).

The literature review concludes by:

1. summarising the benefits that are expected (and have been achieved) from ERP systems;
2. selecting a relevant ERP PMS for this study; and
3. defining a list of CSFs identified through the research.

The process followed and findings obtained from the literature review is summarised in Figure 2.1.

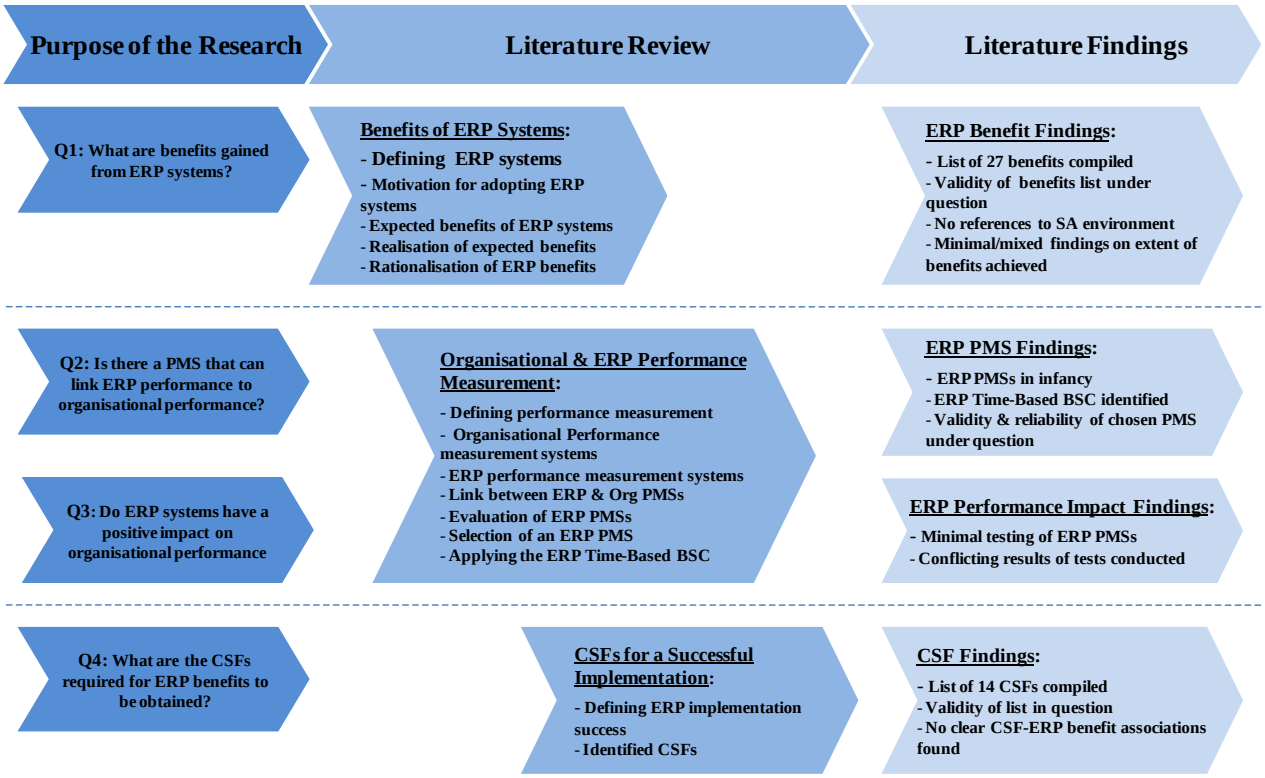


Figure 2.1 Literature review summary

2.1 Benefits of ERP Systems

By investigating the reasons for ERP adoption and comparing the expected and realised benefits of ERP systems this section aims to lay the foundation for answering the question:
What are the benefits gained from ERP systems?

The outcome of this literature review is a consolidated list of ERP benefits.

2.1.1 Defining ERP systems and benefits

ERP systems have been defined by many authors. Yen and Sheu (2004, p207) define an ERP system as an information system that manages, through integration, all aspects of a business including production planning, purchasing, manufacturing, sales, distribution and customer service. Gable (1998) defines it slightly differently, as a comprehensive packaged software solution seeking to integrate the complete range of a business' processes and functions, to present a holistic view of the business from a single information and IT architecture platform. Koch et al (1999) add to this by stating that ERP goes as far as to encompass all integrated information systems that can be used across any organisation. However, for the purpose of this study the ERP definition provided by Nah et al (2001, p285) is used:

"An **ERP system** is a packaged business software system that enables a company to manage the efficient and effective use of resources (materials, human resources, finance, etc) by providing a total, integrated solution for the organisation's information-processing needs"

The Concise Oxford Dictionary defines a benefit as "a favourable or helpful factor or circumstance". When referring to a benefit in this study we are referring to the favourable effect of the ERP system on an organisational performance measurement. Consequently the following definition is used:

An **ERP benefit** is a favourable effect on a performance measure.

2.1.2 Motivation for adopting ERP systems

The need for: real-time and accurate information; standardization of business processes; and integration of applications have emerged as the main drivers for ERP adoption (Spathis and Constantinides, 2003, pp680-681; Poston and Grabski, 2001, p272; Chand, et al, 2005, pp559-560; Sarkis and Sundarraj, 2000, pp203-204; Siriginidi, 2000, pp381-382).

In operating on legacy and "home grown" systems companies have experienced data inconsistencies due to multiple points of entry together with infrequency of data updates. This inaccuracy of data and information has a direct impact on the ability of managers to make decisions. Through the adoption of ERP systems companies aim to eradicate data inconsistencies, thus aiding information quality and decision making ability (Siriginidi, 2000, pp381-382; Spathis and Constantinides, 2003, p681; Poston and Grabski, 2001, pp272-273). ERP systems are further seen to provide a mechanism to drive business process re-engineering initiatives resulting in standardized processes throughout an organisation (Siriginidi, 2000, p381). Companies also see ERP systems as a means to consolidate multiple software systems with hard to maintain interfaces, and multiple support services, into one integrated service offering, thus reducing the burden of software maintenance and support (Chand et al 2005, p559-560).

The evidence suggests that companies view the above drivers as a means to increase firm performance and competitiveness through; reduction of asset bases and costs, increased sales and improved customer service (Spathis and Constantinides, 2003, p681; Poston and Grabski, 2001, pp272-273; Chand et al, 2005, p559-560).

2.1.3 Expected benefits of ERP systems

Chand et al (2005, p559) refer to Markus and Tanus' (2000) suggestion that there should be a connection between reasons for ERP adoption and ERP benefits. Keeping this in mind, the literature on expected ERP benefits has been reviewed, and this link confirmed by certain research:

Chand et al (2005, p560) and Nah et al, (2001) note the benefit of timely and accurate information. Chand et al (2005, p559) and Poston and Grabski (2001, p272) continue to discuss the resultant decision making benefits that are expected. Chand et al (2005, p560), Nah et al (2001, p285) and Poston and Grabski, (2001, p272) describe the benefit of having increased integration of applications. Chand et al, (2005, p559-560) and Shang and Seddon (2002, p277) note the expected reduction in IT operating costs. The use of ERP implementations as a platform for Business Process Reengineering (BPR) and the resultant benefit of improved business processes are discussed by Chand et al (2005, p559-560), Nah et al (2001, p285) and Poston and Grabski (2001, p273).

The authors cited above also list other benefits of ERP systems, including: reduced stock levels; reduced operating and administration costs; increased business/sales; reduced cycle times; improved customer service; reduction in lead times; improvement in on time deliveries; increased inventory turns; reduced quality costs; and improved information sharing.

2.1.4 Realisation of expected benefits

In this section quantitative and qualitative studies are reviewed to determine the extent to which the expected benefits discussed above have been realised by implementing firms.

Sarkis and Sundarraj (2000, p198), by adopting a case study approach, provide evidence of the benefits of improved customer service, integrated business processes and systems, increased sales and improved response to requirements (decision making). However, by also discussing a failed implementation they emphasis the point that these benefits are not always achieved and are dependent on a number of CSFs. Mandal and Gunasekaran (2003, p281) add to the evidence of ERP related business process improvements through their case study of a SAP implementation. They also discuss the achieved benefits related to increased information availability and sharing. The work of Gupta and Kohli (2004) adds further support to the benefits of improved business processes, enhanced business

decision making and improved information sharing. Spathis and Constantinides (2003) adopted a survey approach to validate the benefits of ERP systems. Their research adds further credibility to the evidence of the case studies above by reporting the main resulting benefits of ERP adopters to include increased integration of applications, improved availability and quality of information and improved decision making. Other benefits supported by the research of Spathis and Constantinides (2003, p680) include: easy maintenance of databases; increased user-friendliness of Information Systems (IS); reduction of time for issuing of reports-statements; improved co-ordination between departments; reduction in errors in logistics; increased internal communication; reduction in time for transaction processing; and improved delivery times.

By comparing the performance of adopters and non-adopters Hunton et al (2003) found the performance of ERP adopters to be significantly higher than non-adopters, although this was attributed to the decline in performance of non-adopters versus the relative sustained performance of adopters. However, by adopting a similar comparison Wieder et al (2006) found no significant performance difference between ERP adopters and non-adopters either at the supply chain or overall firm levels.

The work of Al-Mashari and Al-Mudimigh (2003) and Al-Mashari and Zairi (2000) focuses on case studies of failed ERP implementations and discusses situations where benefits have failed to be realised. Their research does not denounce the prospect of ERP benefits, but rather highlights the fact that benefits are not always realised.

2.1.5 Rationalisation of ERP benefits

The investigation into the realisation of expected benefits shows that in many cases the expected benefits identified in section 2.1.3 are validated through the surveys and case studies that have been conducted. Although examples are noted where benefits have failed to be realised, this does not disprove the existence of

these benefits but rather emphasises the point that these benefits are not guaranteed; and hence the need for further research in this field.

Table 2.1 compiles the ERP benefits identified in the literature for further analysis and testing. The table details the amount of support for each benefit identified, and ranks the expected benefits according to the amount of support found in the literature. An equal weighting system has been applied, regardless of the source of the information (i.e. literature review, case study or survey). Expected benefits are ranked as either "A", "B", "C" category benefits; with "A" benefits having over 50% support, "B" benefits 30 or 40% support, "C" benefits 10 or 20% support. For example, "improved information sharing" is supported by six articles and is therefore classified as an "A" benefit. As all these benefits have been supported in the literature it has been decided to use the full list in the structured interview phase of this investigation. If during the structured interview phase it becomes evident that certain "B" or "C" measures are not applicable to the study the list is to be modified.

Table 2.1 Expected ERP benefits

Source of Information	Literature Analysis	Literature Analysis	Literature Analysis	Literature Analysis	Survey	Case Studies	Literature & Case Studies	Case Studies	Case Studies	Case Studies	
Benefit \ Author	Siriginidi (2000)	Nah et al (2001)	Chand et al (2005)	Poston & Grabski (2001)	Spathis & Constanti-nides (2003)	Sarkis & Sundarraj (2000)	Shang & Seddon (2002)	Davenport (1998)	Mandal & Gunasek-aran (2003)	Gupta & Kohli (2004)	Rank
Improved accuracy & timeliness of information	✓	✓	✓	✓	✓			✓	✓		A
Improved information sharing		✓		✓	✓			✓	✓	✓	A
Improved business processes	✓	✓	✓	✓					✓	✓	A
Increased integration of applications		✓	✓		✓	✓	✓				A
Improved decision making			✓	✓	✓		✓			✓	A
Reduced operating and admin costs		✓	✓	✓	✓		✓				A
Reduced stock levels	✓	✓	✓		✓						B
Increased business/sales	✓			✓		✓	✓				B
Reduced cycle times	✓	✓		✓			✓				B
Improved customer service	✓			✓		✓	✓				B
Improved productivity and efficiencies				✓			✓	✓		✓	B
Improvement in on time shipments	✓				✓			✓			B
Reduction in IT operating costs			✓		✓		✓				B
Reduction data processing time			✓		✓			✓			B
Reduction in lead times	✓					✓					C
Increased inventory turns	✓				✓						C
Reduced quality costs/quality improvement	✓						✓				C
Improved vendor performance	✓			✓							C
Improved resource utility	✓										C
Increased user friendliness of IS					✓						C
Changing work patterns							✓				C
Facilitating organisational learning							✓				C
Empowerment							✓				C
Building common vision							✓				C

Note: refer to Figure F8 for detailed definitions of above benefits

2.1.6 Summary of ERP benefits

This section of the literature review confirms Markus and Tanus' (2000) view that a correlation can be found between an organisation's reasons for adopting ERP systems and the resultant benefits that are expected. The main reasons for adoption and expected benefits were found to be:

1. improvement in data accuracy and availability to aid decision making;
2. business process re-engineering to improve business performance (decrease cost and increase productivity and revenues); and

3. integration of applications to reduce IT costs and increase information sharing and decision making.

The investigation into the realisation of expected benefits revealed that in some cases the targeted benefits of ERP systems are being achieved. However, the degree to which these benefits are being achieved and thus affecting organisational performance was not confirmed. Added to this, the reports of failed implementations raise questions over the proportion of benefits being achieved to the number of ERP implementations. All the articles researched referred to international studies and no confirmation of these benefits being achieved in the South African environment was found. All these factors contribute to the need for further research in the area of ERP benefits.

The literature review enabled a consolidated list of expected ERP benefits to be compiled (refer to Table 2.1). However, the level of support for the identified benefits varies considerably, raising doubt over the validity of this list.

2.2 Organisational and ERP Performance Measurement

To determine the impact that ERP systems are having on organisational performance, the question of how organisational performance should be measured first needs to be addressed. To this end, this section of the research reviews the evolution of organisational performance measurement to determine the current accepted practices of performance measurement and establish why these systems have been adopted. The review then focuses of the methods used for ERP evaluation, to determine if there is a link between the models used to measure organisational performance and the current methods of evaluating the performance impact of ERP systems. Within the evaluation of ERP PMSs the applicability, and previous research findings, using these models is reviewed. The review concludes with the identification of, what is assessed to be, the most appropriate model for evaluating the impact of ERP systems on organisational performance.

2.2.1 Defining performance measurement

In evaluating organisation performance clarity first needs to be given to the definition of performance measurement. Neely et al (1996, p424) describe performance measurement as the process of quantifying action, where measurement is the process of quantification and action correlates with performance. Building on this description, they state that performance can be defined as the "process of quantifying the efficiency and effectiveness of action". Here effectiveness refers to the extent to which certain requirements are met; while efficiency is the measure of how economically a firm's resources are utilized in meeting these requirements. Given the above definition, the terms "performance measure", "performance measurement system" and "organisational performance measurement" are defined as follows:

Performance measure: a metric used to quantify the efficiency and/or effectiveness of action.

Performance measurement system: "the set of metrics used to quantify the efficiency and effectiveness of actions" (Neely et al, 1996, p424).

Organisational performance measurement: the process of quantifying the efficiency and effectiveness of actions within an organisation, using an appropriate set of metrics (adapted from Neely et al, 1996, p424).

2.2.2 Organisational performance measurement systems

Ghalayini and Noble (1996, p124) describe how the literature concerning performance measurement has evolved in two main phases. The first phase describes performance measurement from the late 1880s through to the 1980s. This phase was characterised by its cost accounting orientation. Measurement systems assisted managers in evaluating the relevant costs of operating their firms (with the main focus being on controlling and reducing direct labour costs). Financial measures, such as profit and return on investment, were the main performance drivers (Gomes et al, 2004, p511).

The second phase started in the 1980s as a result of changes in the world market. Eccles (1991, p132) describes how during the 1980s many executives saw a deterioration in their strong financial records due to declines in quality or customer satisfaction, or because of the increased pressure from global competitors. Ghalayini and Noble (1996, p63) describe how companies, in an effort to combat this decline, shifted their strategic priorities from low-cost production to quality, flexibility, short lead times and dependable deliveries. This change in focus was coupled with the introduction of new technologies and philosophies of production management, such as; Computer Integrated Manufacturing (CIM), Flexible Manufacturing Systems (FMS), Just-In-Time (JIT), Optimised Production Technology (OPT) and Total Quality Management (TQM) (Ghalayini and Noble, 1996, p63). Due to this shift in business focus much criticism of existing financial measurement systems began to emerge. Kaplan and Norton (1992, p71) describe how traditional financial measures were internally focused and gave misleading signals for continuous improvement. As a result they called for a balanced measurement approach focusing on both financial as well as operational measures. Eccles (1991) backed up this discontent with traditional financial measurement by emphasising that companies would need to

focus on non-financial measures such as quality and customer service if they were to remain competitive in the 1990s. Neely (1999, p206) concurs with this by summing up the criticisms for traditional financial measures by stating that:

1. They encourage short term thinking, for example the delay of capital investment.
2. They lack strategic focus and fail to provide data on quality, responsiveness and flexibility.
3. They encourage departmental verses organisational optimisation, for example manufacturing inventory to keep people and machines busy.
4. They encourage managers to minimise the variances from standard rather than seek to improve continually.
5. They are rarely integrated with one another or aligned to business processes.
6. They fail to provide information on what customers want and how competitors are performing.

Gomes et al (2004, p515) write that in response to the criticisms associated with traditional financial based measurement systems, a number of integrated PMSs, which include non-financial measures, have been proposed. Gomes et al's research revealed the most cited PMSs to be: the SMART system (Cross and Lynch, 1988), the Performance Measurement Matrix (Keegan et al, 1989), the Balanced Scorecard (Kaplan and Norton, 1992), and the Integrated Dynamic PMS (Ghalayini et al, 1997). The following four subsections review these measurement systems in more detail. This is done to identify common characteristics for measuring organisational performance. By identifying these characteristics a platform is established for a comparison to be done with ERP PMSs to select the most appropriate measurement system for this study.

Strategic Management and Reporting Technique (SMART)

The SMART system was designed by Cross and Lynch (1988) as part of a project for Wang Laboratories that set out to institute a management and control system with performance indicators designed to define and sustain success. Motivated by the inadequacies of traditional financial measurement systems, the SMART system aims to:

1. Link operations to strategic goals and clarify measures of strategic importance.
2. Measure departments and functions on contributions to meeting manufacturing's strategic mission.
3. Integrate financial and non-financial information in a way that can be used by operational managers.
4. Focus activities on future requirements of the business, as dictated by the customer.
5. Change performance, incentive, and reward systems as necessary.

(Cross and Lynch, 1988, p25)

The SMART control system is represented by means of a four level pyramid consisting of objectives and measures that link strategies and operations, as shown in Figure 2.2 (adapted from Cross and Lynch, 1988, p25)

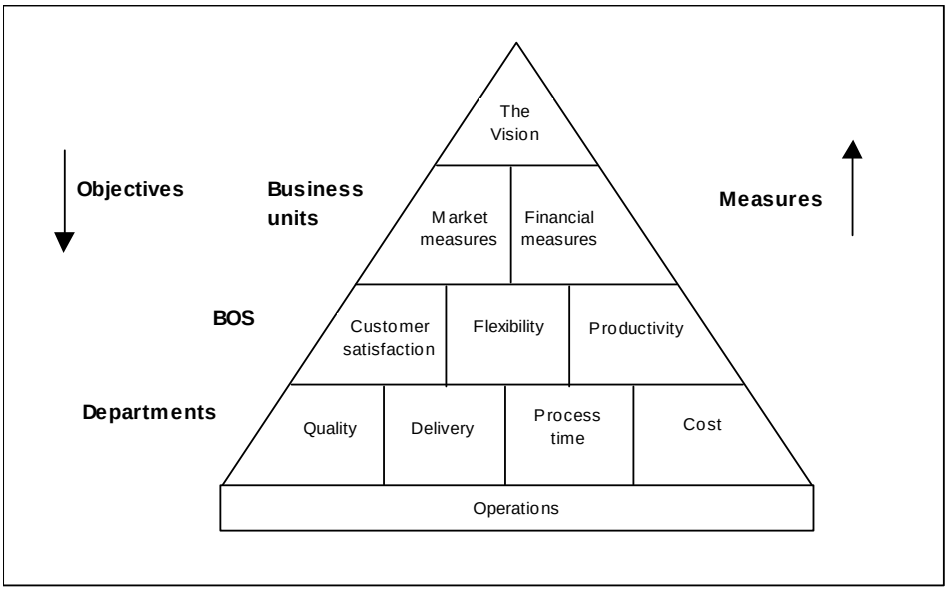


Figure 2.2 The performance pyramid

The top level consists of the vision for the business, which forms the basis of the corporate strategy. The second level consists of business unit objectives defined in market or financial terms. At the third level more tangible operating objectives are defined per Business Operating System (BOS) in terms of customer satisfaction, flexibility and productivity. These objectives become the driving forces involved in every BOS and become defined by the fourth level measures of quality, delivery, process time and cost. By defining objectives from the vision downwards effective measures related to the company's strategy can be defined as one moves down the pyramid. This results in metric changes at the lower levels of the pyramid having a direct impact on the measures above, thus enabling the SMART system to act as a control system for measuring if strategy is being achieved and continuous improvement is taking place.

The Performance Measurement Matrix

Similar to the SMART system, the Performance Measurement Matrix (PMM) uses strategy as a means to define performance measures. Keegan et al (1989) agree with the approach of Cross and Lynch with respect to performance measures being inter-related across departments and becoming more specific as they extend down through the organisation. Another similarity is that both the SMART system and the PMM focus on both internal as well as external measures. Keegan et al (1989) go on to describe how performance measures should be based on an understanding of cost and profit behaviour, but do not have to explicitly relate to these measures as long as they align with corporate strategy. The resultant measurement matrix is made up of a combination of non-financial (non-cost) and financial (cost) measures, and internal and external measures. Figure 2.3 (adapted from Keegan et al, 1989) provides an example of how the performance matrix can be populated with relevant company measures.

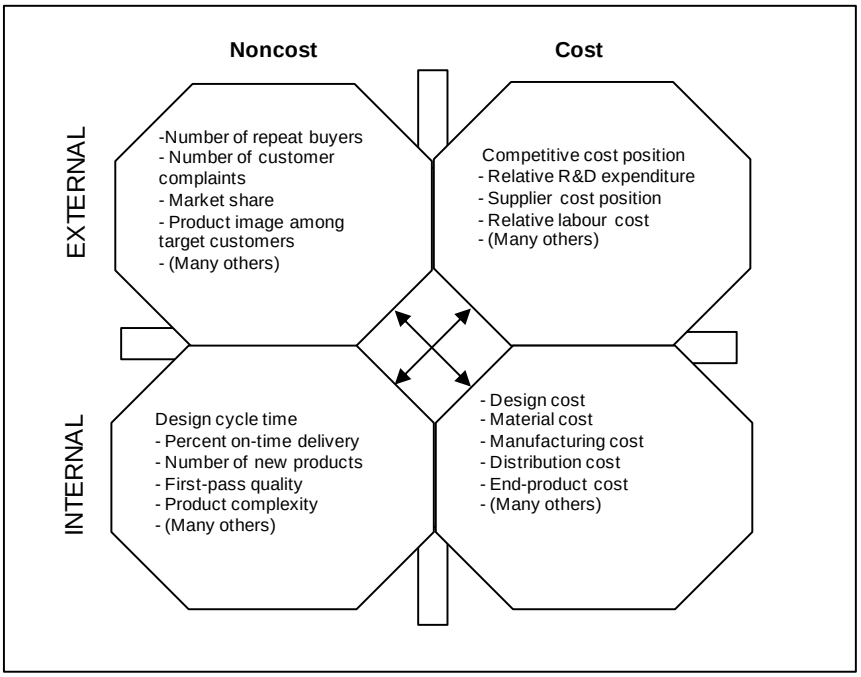


Figure 2.3 Performance measurement matrix

The Balanced Scorecard (BSC)

Gomes et al (2004) cite Kaplan (1983) as one of the main critics of the traditional financial measurement systems in use during the 1980s. As a solution to the measurement problem, Kaplan and Norton (1992) proposed a framework for an integrated performance measurement system that focuses on strategic, operational and financial measures. The Balanced Scorecard (BSC) was designed to provide top management with a set of measures that gives them a brief but comprehensive view of the business. Essentially the BSC provides a framework for companies to define performance from four perspectives linked to a common strategy. These four perspectives are populated with applicable measures by addressing the following questions:

1. How do customers see us? (customer perspective)
2. What must we excel at? (internal perspective)
3. Can we continue to improve and create value? (innovation and learning perspective)
4. How do we look to shareholders? (financial perspective)

(Kaplan and Norton, 1992)

The measurements that result from addressing these questions are then used to populate the Balanced Scorecard framework as shown in Figure 2.4.

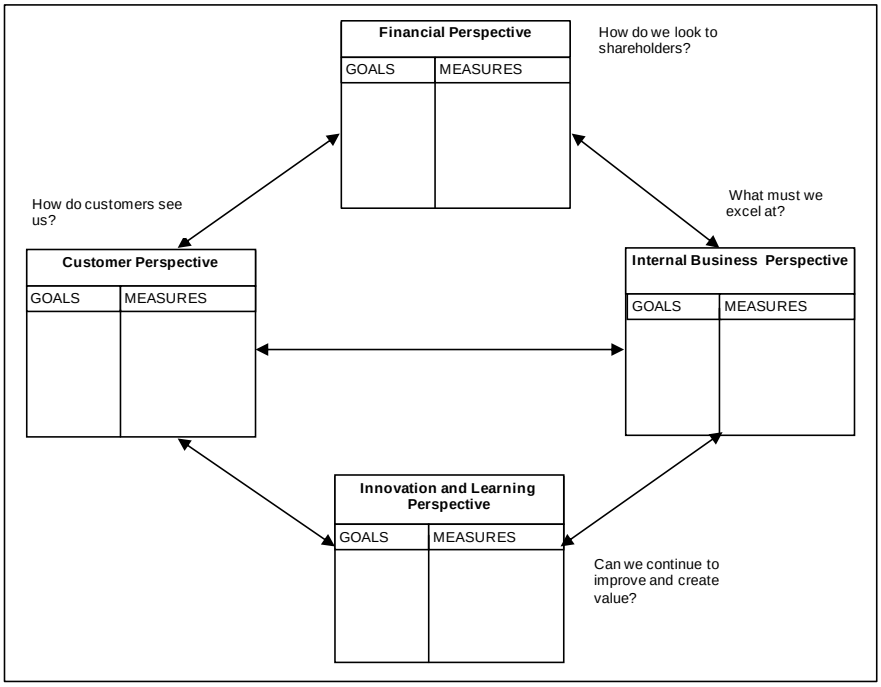


Figure 2.4 The balanced scorecard

Kaplan and Norton's Balanced Scorecard approach concurs with the principles adopted through the SMART and PMM methods in that it aims to:

1. Provide management with a handful of critical performance measures linked to the business strategy.
2. Balance financial and non-financial measures.
3. Focus on internal as well as external (customer perspective) measures.
4. Guard against sub-optimisation by setting and evaluating measures across departments.
5. Focus on continuous improvement (by highlighting measures of innovation and learning).

The Integrated Dynamic Performance Measurement System

Ghalayini et al (1997) claim that although the integrated systems, such as the ones reviewed above, have addressed many of the shortcomings of past performance measurement systems, they have not yet fully addressed the requirements of a performance measurement system for today's manufacturing environment. They claim that the previous integrated measurement systems have the following limitations:

1. They are mainly constructed as monitoring and control tools rather than improvement tools.
2. They do not specify a time horizon for achieving objectives.
3. They are not dynamic systems.
4. They do not look ahead for predicting, achieving and improving future performance.
5. Although some systems stress the importance of global optimisation, they do not provide a mechanism for achieving this.
6. Most systems do not stress the importance of time as a strategic performance measure.
7. None of the models provide a specific tool to model, control, monitor and improve the activities at the factory shop floor level.

(Ghalayini et al, 1997)

To address these limitations Ghalayini et al (1997) designed the Integrated Dynamic Performance Measurement System (IDPMS), which is based on integrating three primary functional areas: management, process improvement teams and the factory shop floor. These functional areas measure and improve performance by utilizing three existing measurement applications: the Performance Measurement Questionnaire (PMQ), the half-life concept, and a Modified Value-Focused Cycle Time (MVFCT) diagram. The "management area" is responsible for defining the "general" and "specific" areas of success that are used within the model. This is achieved by using the PMQ. The "process improvement teams" focus on improving the manufacturing systems' operational and cost performance. The teams utilize the half-life concept to determine

appropriate time horizons, and the modified MVFCT diagram to achieve the improvements within these horizons. The "factory shop floor" focuses on the departmental performance measures that have been linked to the overall performance improvement of the organisation. Figure 2.5 (Ghalayini et al, 1997) illustrates the IDPMS concept and highlights the linkages that enable information flow between the functional areas.

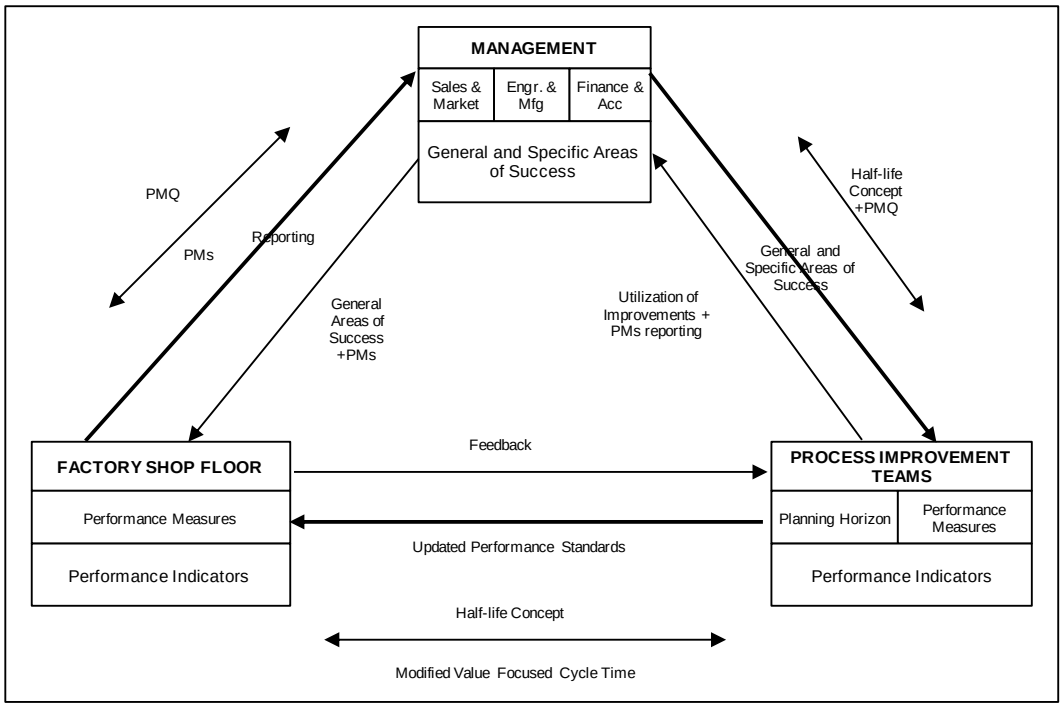


Figure 2.5 Integrated dynamic performance measurement system

Organisational PMS summary

The current literature concurs that traditional measurement systems, based on traditional cost management systems, are no longer applicable to today's organisations (Eccles (1991); Ghalayini and Noble (1996); Neely (1999), and Kaplan and Norton (1992)). Consequently a number of integrated measurement systems were developed that attempt to compensate for the weaknesses of traditional measurement systems. Of the integrated systems reviewed, SMART, PMM and the BSC have the following characteristics in common:

1. They focus on strategy as the starting point for defining and linking performance measures.
2. They emphasise the importance of building measures related to global performance, and avoiding local optimisation (i.e. measures should be "linked" across departments).
3. They agree on the importance of keeping financial measures, but insist on balancing these measures with non-financial measures linked to strategic objectives.
4. They concur that the measurement set must be composed of internally as well as externally focused measures (i.e. all emphasise the importance of customer focused measures).
5. They act as control loops for monitoring continuous improvement.

While the IDPMS shares the above characteristics it attempts to account for the "weaknesses" in the other systems by introducing process based techniques to:

1. Aid the implementation of continuous improvement within specific time horizons.
2. Enable continuous feedback from the shop floor level to create a dynamic feedback system that allows strategy to be monitored and modified (Ghalayini et al, 1997).

Thus, it can be said that whereas the SMART, PMM and BSC can be viewed as strategic based measurement and control systems, the IDPMS focuses on not only establishing relevant strategic based measures, but also facilitating the operational efforts that are required to ensure that strategy and continuous improvement are realised.

2.2.3 ERP performance measurement systems

Whilst there is much literature describing the evaluation of organisation performance, the literature on ERP performance measurement is still emerging. Much of the literature available focuses on the financial impacts of ERP systems (for example, Poston and Grabski, 2001; Hunton et al, 2003). In line with the traditional financial measurement models, these studies focus solely on financial measures such as return on investment, revenue and costs to establish the effectiveness of an implementation.

However, similar to the critics of traditional firm measurement techniques Sarkis and Sundarraj (2000, p212) criticise this technique of focusing on only one set of measures. They stress the need to evaluate ERP systems based on the tangible (quantifiable) and intangible (unquantifiable) benefits. To achieve this they recommend using a number of modelling techniques, for example, the Analytical Hierarchy Process (AHP), simulation and scoring models. They highlight scoring models (where each measure is assigned a weighting factor, and then ranked according to a scale) as the simplest and most popular technique for ERP evaluation.

Shang and Seddon (2002, p274) concur with Sarkis and Sundarraj's criticism of ERP evaluation (utilizing only financial measures) by adding that the difficulty with this method is one of causality, as one cannot be sure that the investments in the ERP system are the cause of observed changes in corporate profitability or market share. As an alternative method they propose an Enterprise System (ES) Benefit Framework. Shang and Seddon (2002) compiled their benefit framework by taking a list of reported enterprise system benefits (from vendor web-sites) and consolidating them into five dimensions, namely: operational, managerial, strategic, IT infrastructure and organisational dimensions (refer to Table 2.2). By re-assessing these benefits at given time intervals the aim is for implementing companies to quantify their benefits to develop Perceived Net Benefit Flow (PNBF) graphs that help to assess the ERP impact on a year by year basis. An

example of the PNBF graphs is shown in Figure 2.6 (Shang and Seddon, 2002, p290).

Table 2.2 Proposed ES benefits framework

Dimensions	Subdimentions (21 at this stage)
Operational	1.1 Cost reduction
	1.2 Cycle time reduction
	1.3 Productivity improvement
	1.4 Quality improvement
	1.5 Customer service improvement
Managerial	2.1 Better resource management
	2.2 Improved decision making and planning
	2.3 Performance improvement
Strategic	3.1 Support for business growth
	3.2 Support for business alliance
	3.3 Building business innovations
	3.4 Building cost leadership
	3.5 generating product differentiation
	3.6 Building external linkages
IT infrastructure	4.1 Building business flexibility for current and future changes
	4.2 IT cost reduction
	4.3 Increased IT infrastructure capability
Organizational	5.1 Changing work patterns
	5.2 Facilitating organizational learning
	5.3 Empowerment
	5.4 Building common vision

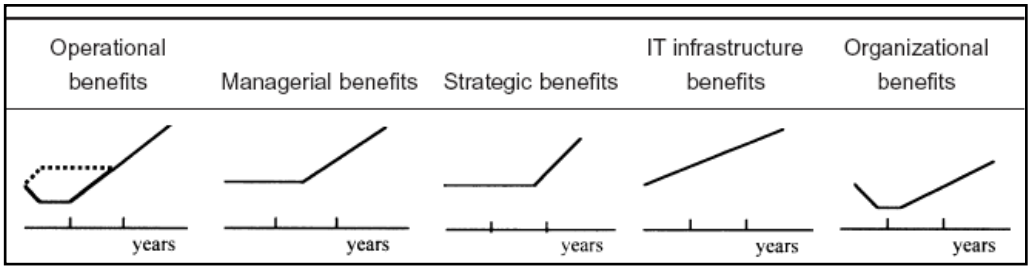


Figure 2.6 Perceived net benefit flow graphs

Wieder et al (2006, p14) continue the argument against using only financial measures to evaluate ERP systems by stating that financial Key Performance Indicators (KPI) fail to explain the increasing diversity and complexity of the life cycle of enterprise systems. As a solution they developed an ERPS Performance Measurement Model using a generic IT-performance measurement framework suggested by Dehning and Richardson (2002) (refer to Figure 2.7). They do this

by redefining IT measures in ERP terms: classifying business process measures based on the Supply Chain Council's Operations Reference model (SCOR-model), and defining firm performance by net profit margins and the current ratio. The result is a model that measures several aspects of ERP adoption and ERP use on firm performance and business process performance.

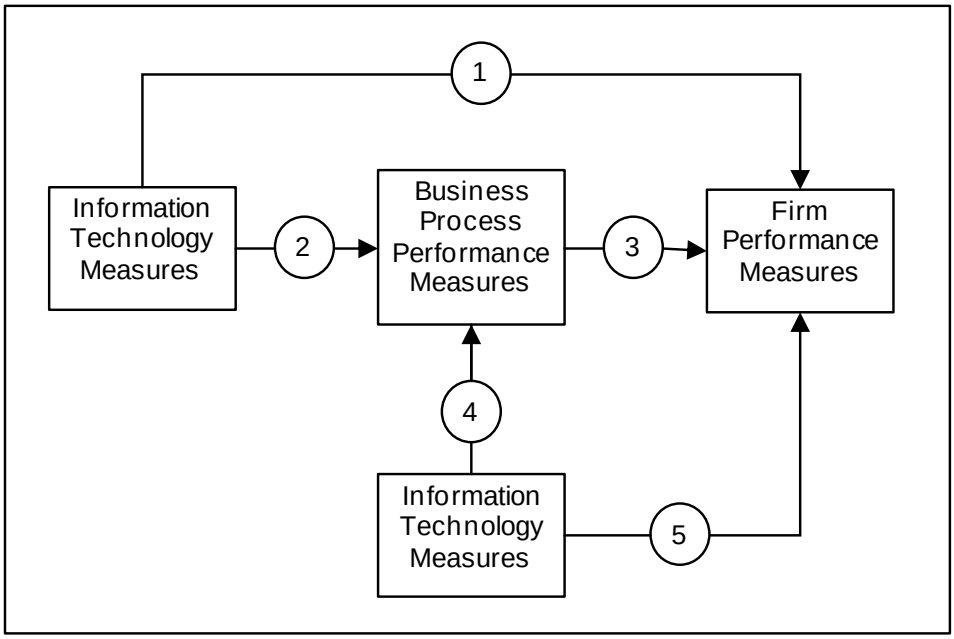


Figure 2.7 Simplified framework for evaluating effects on IT investment

2.2.4 Link between ERP and organisational performance measurement systems

By analysing the above discussions (section 2.2.3) a number of parallels can be drawn between the evolution of ERP performance measurement and firm performance measurement (discussed in section 2.2.2). For example:

1. Initial ERP evaluation models and techniques focused solely on the financial impact of ERP systems.
2. As ERP evaluation models have developed, researchers have called for a balance between financial and non-financial measures.
3. Like the integrated PMS of firm performance, recent ERP evaluation methods have incorporated performance measures linked to strategy and continuous improvement.

4. In line with Ghalayini et al's (1997) view on re-assessing firm performance over measured time horizons, Shang and Seddon (2002) stress the need for a similar review of the ERP performance impact.

Given the above, the question that is now raised is: can the integrated PMSs discussed in section 2.2.2 be applied to measure the impact of ERP systems on organisational performance?

In reviewing the available literature no evidence was found to support the use of the SMART, PMM, or IDPMS systems for ERP performance evaluation. However, evidence of the application of the BSC to information systems, and specifically ERP, evaluation was found:

Martinsons et al (1999) propose the use of the Balanced Scorecard as a means to evaluate IS performance. Since ERP systems fall into the category of IS systems being discussed, this proposal is worth reviewing. Martinsons et al (1999) follow the generic BSC philosophy that performance measures be defined based on strategy and vision, however they suggest altering the four perspectives under which metrics are defined for the following reasons:

1. The IS department is typically an internal (rather than external) service supplier.
2. IS projects are commonly carried out for the benefit of both end-users and the organisation as a whole (rather than individual customers within a large market).

(Martinsons et al,1999, p75)

The four suggested perspectives are:

1. User orientation: here the mission is to deliver value-added products and services to end-users. Metrics focus on user satisfaction and relationship with end users.
2. Business value: here the mission is to contribute value to the business. Metrics focus on cost, sale of IS products and services, and measures of IS business value.

3. Internal processes: here the mission is to deliver IT products in an efficient and effective manner. Metrics revolve around the planning, development and operations phases of projects.
4. Future readiness: here the mission is to deliver continuous improvement and prepare for future readiness. Metrics reflect improvement in skill sets, updating of applications portfolio, and research into emerging technologies.

Although the above method remains largely untested, and the authors recommend that further research is required, the model does describe a useful application of the BSC in not only evaluating the end result of an implementation, but also the implementation process itself.

Chand et al (2005) state that although several authors have suggested developing an ERP Balanced Scorecard, they cite Rosemann and Wiese (1999) as the only ones to attempt this approach. However, they describe Rosemann and Wiese's method as being faulty as it does not connect with the business and strategic goals of an organisation. Subsequently, their research sets out to determine if an analytical framework can be built to systematically analyse the benefits and strategic contributions of an ERP system. To link the BSC to the business goals and strategy of an organisation they adopt Zuboff's (1985) notion that the success of an ERP implementation and operation depends on the firm's intention to use the ERP system to "automate", "informate" and "transformate" the organisation. The result of their research is a 12-cell ERP scorecard that integrates the four BSC dimensions with Zuboff's "automate", "informate" and "transformate" goals of information systems. To test this model, Chand et al conducted a case study of a SAP implementation where they used the performance measures determined through the study to populate the scorecard, and then evaluated the impact of the implementation. The scorecard framework is reproduced in Table 2.3.

Table 2.3 ERP scorecard

	Process	Customer	Finance	Innovation
Automate Operational benefits Goal Outcomes	 1. XXX 1. xxx 2. xxx etc.			
Informate Tactical benefits Goal Outcomes				
Transformate Strategic benefits Goal Outcomes				

2.2.5 Evaluation of ERP performance measurement systems

The preceding sections revealed that although there is no commonly accepted measurement system for evaluating ERP systems (as confirmed by Chand et al, 2005, p559), the criteria recommended for evaluating ERP performance are largely the same as those required for measuring organisational performance in general. Therefore, in deciding on an ERP measurement system to use in this study it is proposed that the following criteria be met:

1. The system must connect measurements with business goals and organisational strategy.
2. The system must consist of a balanced set of financial and non-financial measures that can be linked to strategic objectives.
3. Measures must be internally as well as externally focused.
4. The system must enable performance to be reviewed over specified time horizons against specific goals (i.e. allow for time-factor analysis to be performed).
5. The system should be easy to use to enable improvements to be monitored on a regular basis.

The ERP measurement systems identified in the preceding sections that appear to exhibit the majority of these characteristics and are therefore considered for selection are:

1. ES Benefit Framework (Shang and Seddon, 2002);
2. ERPS Performance Measurement Model (Weider et al, 2006);
3. ERP Scorecard (Chand et al, 2005); and

Since the principles behind the BSC (and by association the ERP Scorecard) are largely the same as those behind the SMART and PMM systems, the option of developing the SMART and PMM models into ERP measurement systems is not considered. However, because the IDPMS (Ghalayini et al, 1997) strongly challenges many aspects of the other integrated measurement systems and provides a number of recommended improvements (for example, measuring objectives over specific time horizons) the option of developing the IDPMS into an ERP PMS is considered:

4. IDPMS.

The following section reviews each of the four selected systems based on the criteria discussed above. Table 2.4 summarises the results of the analysis.

ES Benefit Framework

In reviewing the ES Benefit Framework it can be seen to consist of a balanced set of financial and non-financial measures. These measures are mainly internally focused, with only a few externally focused measures, for example, "customer service improvement" and "building external linkages". However, it can be argued that if more externally focused measures are required these can easily be added to one of the five categories. Time-factor evaluation is dealt with by means of PNBF graphs, although these graphs are used for retrospective analysis and do not define specific time periods during which targeted benefits should be achieved. The major drawback with this system as pointed out by Chand et al (2005, p559) is that it does not link benefits specifically to reasons for adoption and therefore strategy.

In terms of ease of use Shang and Seddon (2002) demonstrated through a series of case studies that this system is an efficient method of evaluation. These case studies indicate a positive impact of ERP systems on firm performance over time. However, as only four cases were studied Shang and Seddon do not claim the findings to be comprehensive, but rather suggest that the framework be used in a broader market study.

ERP Performance Measurement Model

This model consists of both financial and non-financial measures. The model attempts to link benefits based on the overall strategy of a firm, by linking benefits to the firm performance measures of net profit margins and the current ratio (Wieder et al, 2006, p18). Although externally focused measures are included in the model, these measures are minimal and no attempt is made to categorise these measures from the internal measures. No time-factor analysis of measures was found in reviewing this model.

Regarding the testing/implementation of this model, Wieder et al (2006) used it to assess the feedback of a comprehensive survey conducted within the Australian market. The findings indicate no significant performance differences between adopters and non-adopters. However, it was found that ERP adopters that also adopted Supply Chain Management (SCM) systems achieved significantly higher performance at a business process level.

ERP Scorecard

Like the Balanced Scorecard, the ERP scorecard provides a framework for defining benefits based on business strategy and goals. Although the model does not specify a generic set of expected benefits, it does provide a means for defining a balanced set of measures. By separating "customer" and "process" measures the framework ensures that measures are internally as well as externally focused. The model also attempts to incorporate a time-based dimension by categorising measures according to the implementation goals of "automate", "informate" and

"transformate" that are expected to occur at various periods of the implementation cycle. Although this does add a valuable aspect to the model, these categories may be open to interpretation and do not adequately define time periods over which evaluations should take place.

Regarding ease of use, the case study shows that this model can be applied to analyse an ERP implementation. Chand et al (2005) successfully use this model in a case study to reveal the positive impact of the ERP system on the organisational performance of the firm. The widespread use of the BSC (Kaplan and Norton, 1996) adds further support to the notion that this framework may be relatively straightforward to adopt.

IDPMS

The IDPMS is designed to determine performance measures based on strategy by using the Performance Measurement Questionnaire (PMQ). Therefore, by applying the same methodology, the PMQ could be used to analyse the areas where most improvements could be gained through the ERP system and a balanced set of related measures (financial and non-financial, and internal and external) could be developed. By applying the half-life concept in a similar method to that recommended by Ghalayini et al (1996), time horizons for improvement goals could be set. However, due to the level of detail (i.e. focusing down to shop floor measures and improvement efforts) required by this model this method seems to be more suited to a single case study where customisation of the tool can take place and continuous improvement efforts can be focused on by management to shop-floor personnel. Due to the complexity and time involved in implementing such a model, it is deemed too resource intensive for the current study.

ERP PMS evaluation summary

Table 2.4 summarises the results of the preceding analysis.

Table 2.4 ERP PMS evaluation

Criteria \ ERP PMS	ES Benefit Framework	ERP PM Model	ERP Scorecard	IDPMS Model
Connects with business goals and organisation strategy		✓	✓✓	✓✓
Balanced set of financial and non-finacial measures	✓✓	✓	✓	✓
Internally and externally focused	✓	✓	✓✓	✓✓
Time-factor evaluation	✓		✓	✓✓
Ease of use	✓✓		✓✓	

Key:	
✓✓	Meets requirements
✓	Partially meets requirements

2.2.6 Selection of an ERP PMS

Based on the evaluation it is decided that the ERP Scorecard best meets the requirements of the ERP performance measurement system required for this study. The two "weak points" of the system, as pointed out in the previous section, are addressed as follows:

1. **Defining a balanced set of measures**: the framework is populated using the benefits identified through the literature review. (This categorisation is an attempt that needs to be assessed through validity checks.) These benefits are refined in Chapter 4 by using a questionnaire (similar to the PMQ adopted by Ghalayini et al, 1997) within a structured interview process.
2. **Time-factor evaluation**: by replacing Chand et al's (2005) implementation goals of "automate", "informate" and "transformate" with the implementation life cycle phases of "go-live", "stabilisation" and "optimisation" (adapted from, Anderegg, 2000, pp53-93; Harwood, 2003,

pp155-164) a more time oriented evaluation model results. These three time periods are defined as follows:

Go-live: the period during which a company begins to operate on an ERP system, using the system inputs and outputs to manage and control business activities.

Stabilisation: the period during which the system is "bedded down", i.e. the business becomes competent at operating on the ERP system.

Optimisation: the period during which management and users have gained knowledge of the system and are focused on maximising the value gained from the system.

By addressing these two areas of the ERP Scorecard a modified scorecard, termed the ERP Time-Based BSC, results. Table 2.5 displays the framework of the ERP Time-Based BSC.

Table 2.5 ERP Time-Based BSC

Perspective	Benefit	Time Period		
		Go-live	Stabilisation	Optimisation
Financial Perspective	Operating and administration costs			
	Stock levels			
	Turnover/sales			
	IT operating costs			
	Quality costs			
Internal Business Perspective	Productivity and efficiencies			
	Resource utilization			
	Enhanced business processes			
	Cycle times			
	Data processing time			
	Inventory turns			
	Accuracy and timeliness of information			
	Internal information sharing			
	Lead times			
	Integration of applications			
	Improved decision making			
	Vendor performance			
Customer Perspective	Customer service			
	On time shipments			
	Quality			
	External information sharing			
	Service lead times			
Learning and Growth Perspective	User friendliness of IS			
	Changed work patterns			
	Organisational learning			
	Empowerment of employees			
	Building of a common vision			

Determining time durations for the ERP Time-Based BSC

Learning curves. The relationship between learning and changes in productivity was first formally researched by Wright in 1936 (Plaza and Rohlf, 2008). Learning curves were initially used to forecast productivity in the manufacturing and service sectors. Russell and Taylor (1995, p470) define a learning curve as: "a graph that reflects the improvement rate of workers as a job is repeated and more units are produced". Since their conception, learning curves have been extended to measure the impact of learning on project performance. When learning curve models are used on technology and IS projects they are often called progress curves (Malerba, 1992). Progress curves model practice and performance, where practice is represented in units of time, and performance is measured as a rate, in which a predefined output is produced. Plaza and Rohlf (2008, p74) state the S-curve is one of the two functional forms of the progress curve most often used on IS projects (the other form being an exponential curve). The S-curve takes into account a start-up effect, where as the exponential curve does not. An exponential progress curve representing the skills required by a group of ERP users may look similar to Figure 2.8.

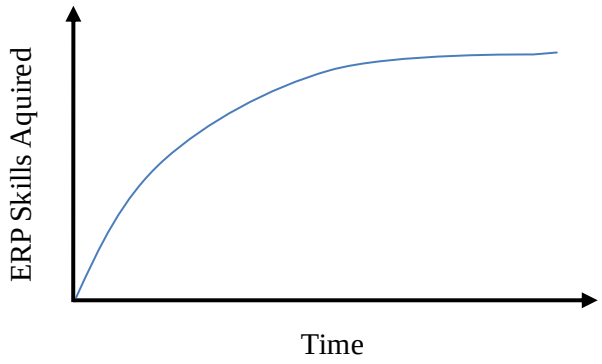


Figure 2.8 Typical ERP learning progress curve

The impact of this learning curve can result in a decline in firm performance in the period immediately following "go-live" before performance begins to increase (Musaji, 2005). If this is the case an ERP progress curve (S-curve), similar to the typical IS progress curve (described by Plaza and Rohlf, 2008) would result:

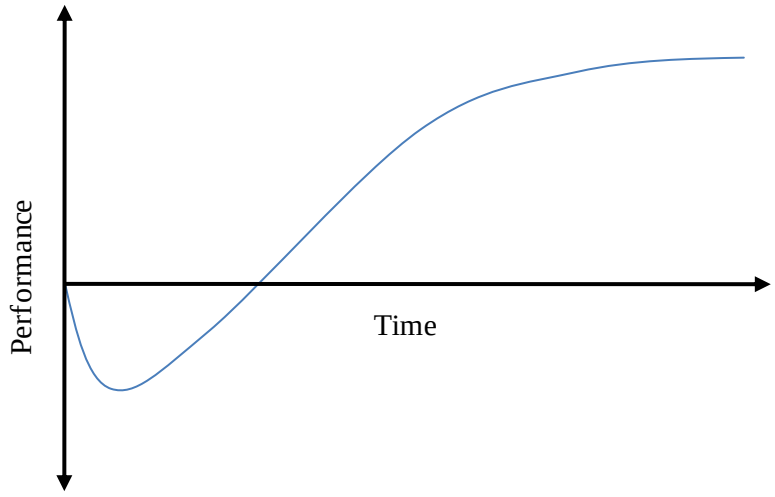


Figure 2.9 Example of an IS S-curve

Defining time period duration. The time taken for users to acquire the necessary skills to effectively utilize an ERP system to its full potential can often take months, or even years (Musaji, 2005; Plaza and Rohlf, 2008, p74). This implies that the time scale shown on Figure 2.9 could be years in the case of ERP implementations.

Both Shang and Seddon (2002) and Hendricks et al (2007) have been successful with evaluating ERP performance over a three year post "go-live" period. In compliance with these findings (and the discussion above) it has been decided to use "three years" as the evaluation period for this study. Based on the trends noted in Shang and Seddon's (2002) findings the time periods of "go-live", "stabilization" and "optimisation" are assigned to one year buckets for this research, i.e.:

1. Go-live = "year 1" (period immediately following the transition to the ERP system);
2. Stabilisation = "year 2"; and
3. Optimisation = "year 3".

Linking the ERP Time-Based BSC to organisational performance

ERP performance needs to be related to organisational performance. Therefore, the ERP strategy that the measures relate to must be linked to the organisational strategy as a whole. In deciding on an ERP strategy for this model, the ERP strategy component has been formulated by considering the main motivation for adopting an ERP system (as detailed in section 2.1.2). The organisational strategy component is taken to be an increase in net profit, maintained on an ongoing basis (as used by Wieder et al 2006). Consequently the ERP strategy for companies using this model is defined as:

"*To integrate applications, enhance information availability and optimise business processes to maximise net profit within the organisation.*"

Kaplan and Norton (1996, pp147-165) explain that BSC measures need to be linked to organisational strategy. To achieve this they first recommend using a cause-and-effect tree to display relationships hypothesised through the strategy. Figure 2.10 proposes the cause-and-effect relationships implied in the ERP strategy definition above.

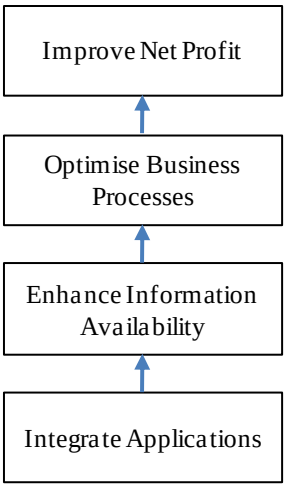


Figure 2.10 ERP strategy cause-and-effect tree

Once the associations within the strategy have been defined, Kaplan and Norton (1996, p148) specify that each measure should be linked to the component of the strategy that the measure most directly affects. Again they recommend the use of

a cause-and-effect tree for this purpose. However, as the accurate compilation of such a diagram would involve a detailed investigation into the relationships between the various benefits a simplified approach is adopted. Table 2.6 provides a high level mental model of how the various benefits may be incorporated into the ERP strategy.

Table 2.6 Strategic links in the ERP Time-Based BSC

Key: Strategy Link	
NP	Improve Net Profit
BP	Optimise Business Processes
INFO	Enhance Information Availability
INT	Integrate Applications

Perspective	Benefit	Time Period			Strategy Link
		Go-live Year 1	Stabilisation Year 2	Optimisation Year 3	
Financial Perspective	Operating and administration costs				NP
	Stock levels				NP
	Turnover/sales				NP
	IT operating costs				NP
	Quality costs				NP
Internal Business Perspective	Productivity and efficiencies				BP
	Resource utilization				BP
	Enhanced business processes				BP
	Cycle times				BP
	Data processing time				INT
	Inventory turns				BP
	Accuracy and timeliness of information				INFO
	Internal information sharing				INT
	Lead times				BP
	Integration of applications				INT
	Improved decision making				NP
	Vendor performance				BP
Customer Perspective	Customer service				BP
	On time shipments				BP
	Quality				BP
	External information sharing				INFO
	Service lead times				BP
Learning and Growth Perspective	User friendliness of IS				INFO
	Changed work patterns				BP
	Organisational learning				INFO
	Empowerment of employees				BP
	Building of a common vision				INFO

2.2.7 Application of the ERP Time-Based BSC

The ERP Time-Based BSC is used to evaluate the impact of an ERP implementation by asking business users to rate the level of improvement for each benefit across the three time periods (using a 7 point Likert scale ranging from "high performance reduction (-3)" to "high performance improvement (3)"). Once the benefit ratings are complete, the averages are calculated to determine the overall impact for each perspective. An equal weighting is then applied to these perspective averages to calculate the impact on organisational performance. An equal weighting system is chosen to ensure a balanced focus on the four perspectives.

Once the scorecard has been completed for the three periods, progress curves are constructed to visually display the rate of performance improvement / reduction.

2.2.8 Summary of organisational and ERP performance measurement

This section reviewed the evolution of organisational and ERP performance measurement methods to answer the questions:

1. *Is there a valid and reliable PMS that links ERP performance to organisational performance?*
2. *Do ERP systems have a positive impact on organisational performance in the time periods following implementation?*

Similarities were drawn between organisational performance measurement methods and ERP measurement methods. It was established that an appropriate measurement system needs to:

1. Be linked to business goals and strategy.
2. Consist of a balanced set of financial and non-financial measures.
3. Be internally as well as externally focused.
4. Allow for time-factor analysis.
5. Be easy to use.

In evaluating ERP performance measurement systems, the ERP Scorecard was assessed to be the most appropriate system. However, two weaknesses, namely lack of predefined measures and unclear time horizons were highlighted. To address this, modifications were made to the model, and the ERP Time-Based BSC was proposed.

By selecting the ERP Time-Based BSC the first question asked above is partially satisfied, as a PMS linking ERP performance to organisational performance (over time) has been identified. However, as the validity and reliability of this PMS has not been confirmed this question still requires further investigation.

In investigating whether ERP systems have a positive impact on organisational performance over time the literature provided mixed results. All of the ERP PMSs showed limited market testing and in cases provided conflicting results: Shang and Seddon (2002) and Chand et al (2005) tested their respective frameworks by

means of a case study approach which indicated that ERP systems do have a positive impact on organisational performance. However, when applying an ERP performance measurement model within a broader survey, Wieder et al (2006) found no significant performance difference between ERP adopters and non-adopters.

Due to: the lack of previous research; the conflicting findings discussed above; and the absence of research within the SA market, the second question is unable to be answered by the literature review and the question therefore remains:

Do ERP systems have a positive impact on organisational performance in the time periods following implementation?

2.3 Critical Success Factors for a Successful Implementation

Whereas the first two sections of the literature review focus on establishing and measuring the benefits of ERP systems, this section focuses on the causes for benefits being achieved, or an implementation being considered successful. This section forms the platform for addressing the question:

What are the CSFs associated with ERP benefits being achieved?

To this end the available literature is reviewed to determine the main contributing factors to ERP success as stated by the experts and backed up through field surveys and case studies. The findings of the literature review are consolidated to form a summarised list of CSFs indicating the level of support found for each factor.

2.3.1 Defining ERP implementation success

Before factors can be attributed to ERP success, clarification needs to be given to the terms "ERP implementation success" and "critical success factor". Soja (2006, p421) adopts a definition of a successful implementation on the understanding of "success" in the information system domain (Lyytenin, 1988), stating that ERP implementation success is "perceived as the completion of assumed goals and implementation scope within a planned time and budget, while achieving user satisfaction". Gargeya and Brady (2005, p502) build on this definition by stating that an ERP implementation can achieve various levels of success, from a complete failure to a partial/or complete success. They define a complete success as "one in which everything goes off without a hitch, or one in which there are few alignment problems, resulting in minor inconvenience or downtime". For the purpose of this study the follow definitions are used:

ERP implementation success: the completion of implementation goals and scope, within a predetermined timeline yielding predefined benefits to the organisation.

Where "implementation" refers to the planning, set-up, "go-live" and post "go-live" phases of an ERP installation.

Critical success factor: any attribute deemed instrumental in achieving a successful implementation.

2.3.2 Identified critical success factors

A review of 51 articles was conducted to determine the factors deemed most critical to ERP success. Of the articles reviewed, eleven were selected based on the depth of research undertaken. The critical success factors around which most consensus was established are represented in Table 2.7. The importance of these CSFs as described by the literature is summarised in the subsections that follow.

As in the case of the ERP benefits table, the CSFs have been ranked according to the level of support received from the literature. Once again each article has been given an equal weighting, and CSFs assigned a ranking of "A", "B" or "C" depending on the level of support received. CSFs ranked as "A" receive support from between 8-10 of the articles, "B" CSFs receive support from 5-7 of the articles, and "C" CSFs receive support from five or less articles.

Table 2.7 Critical success factors

Source of information	Literature Analysis	Literature Analysis	Literature & Case Study	Literature & Simulation	Literature Analysis	Literature Analysis	Questionn-aire & Interviews	Market Questionn-aire	Case Study	Case Study	Case Study	ABC classifi-cation
CSF \ Author	Nah et al (2001)	Gargeya & Brady (2005)	Umble et al (2003)	King & Burgess (2005)	Siriginidi (2000)	Al-Mashari et al (2003)	Kumar et al (2003)	Soja (2006)	Al-Mashari & Al-Mudimigh (2003)	Al-Mashari & Zairi (2000)	Motwani et al (2005)	
Business plan, vision & strategy	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	A
Top management commitment	✓	✓	✓	✓	✓	✓		✓	✓		✓	A
Project management	✓		✓	✓		✓	✓	✓	✓	✓	✓	A
Change management	✓		✓			✓	✓	✓	✓	✓	✓	A
BPR	✓	✓			✓	✓			✓	✓	✓	B
Education and training		✓	✓		✓	✓	✓	✓	✓			B
ERP team composition	✓	✓	✓		✓		✓	✓			✓	B
Minimum customisation	✓	✓			✓		✓	✓	✓			B
Performance evaluation	✓		✓			✓		✓			✓	B
Effective communication	✓			✓		✓			✓		✓	B
ERP package selection			✓	✓		✓	✓				✓	B
Software development, testing & troubleshooting	✓	✓				✓	✓					C
Appropriate business & legacy systems management	✓					✓		✓				C
IT infrastructure					✓		✓			✓		C

The CSFs are explained in the order given in Table 2.7, with the classification indicated on the heading line.

Business plan, vision and strategy (A)

Nah et al (2001, p291) state that a clear business plan and vision that outlines proposed benefits, resources, costs, risks and timelines is needed throughout an ERP life cycle. This helps keep the focus on business benefits. It also ensures that the project does not lose focus, thereby allowing scope creep to occur (Al-Mashari and Al-Mudimigh, 2003, p29). The importance of having a clear plan and strategy has been validated through a number of surveys and case studies (for example, Soja, 2006, p427; Motwani et al, p541).

Top management commitment (A)

Leadership and top management commitment are among the most critical factors attributed to organisations achieving a successful ERP implementation (Al-Mashari et al, 2003, p356; Umble et al, 2003, p245). Siriginidi (2000, p385) writes that top management has to prioritise the implementation project and allow for a mindset change to facilitate learning, exchange of ideas, and ultimately a successful implementation. It is also up to the top management to set the vision and direction for the business, and harness the energy of the employees to ensure that the implementation goals are achieved (Al-Mashari et al, 2003, p356). The importance of top management commitment is backed up through the research conducted by Soja (2006) and Gargeya and Brady (2005).

Project management (A)

Successful ERP implementation requires that project management techniques, including defining clear objectives, developing a deadline driven but achievable project plan, and carefully tracking project progress, be adhered to (Umble et al, 2003, p245). Umble et al (2003) go on to explain that project management must be thorough with co-ordinating training and human resource related issues, and must ensure that all issues and conflicts are managed and resolved quickly. Project management must also be focused on results and deliver on early

measures of success (Nah et al, 2001,p292). The importance of project management to a successful implementation is confirmed by the case studies conducted by Al-Mashari and Zairi (2000) and Motwani et al (2005).

Change management (A)

Change management involves facilitating the introduction of newly implemented systems, processes and structures into the working practice, and deals with resistance to change (Al-Mashari and Zairi, 2000, p311). The work of Kumar et al (2003, p805) provides evidence that a large proportion of firms emphasise the need for change management programs to support the organisation structure and culture changes brought on by ERP systems. Despite this commitment, Al-Mashari et al (2003, p361), find that about half of enterprise systems fail to achieve hoped for benefits, due to managers underestimating the efforts required to effectively manage the high degree of changes involved.

Business Process Re-engineering (BPR) (B)

Nah et al (2001, p293-294) write that it is important to align business processes to the new ERP system to encourage minimum customisation of the ERP software, and enable the implementing firm to take full advantage of the benefits of the new system as well as the introduction of version updates. Al-Mashari et al (2003, p359) add to this by stating that because ERP systems are essentially developed as instruments for improving business processes such as manufacturing, purchasing, or distribution, ERP implementation and BPR activities should be closely connected. The negative impact of not aligning business process strategy with the ERP implementation is supported by the case study analysis conducted by Al-Mashari and Al-Mudimigh (2003, p31).

Education and training (B)

Umble et al (2003, p246) stress that ERP training should start early and focus on both the system and the business process aspect to enable people to solve problems within the framework of the system. If this is not done users may manipulate the system to fit aspects of their own processes, thus affecting the

performance benefits of the ERP system. The literature research by Gargeya and Brady (2005, p511) reveals that the "people element" and training aspect of ERP implementations have historically received the least amount of attention by implementing firms. They state that the paradox here is that when this factor is ignored or downplayed, primary because it does not have the largest quantifiable benefit, expenses are greatly increased in the long run. The market research of Kumar et al (2003, p801) supports the importance of education and training, with their survey results indicating the critical role that trained and knowledgeable staff play in ensuring the success of an implementation. Their research findings also stress the shortage of ERP skills available and the need for ongoing training to ensure the successful use of the ERP system.

ERP team composition (B)

Siriginidi (2000, p385) specifies that the best and most committed people need to be assigned to the ERP implementation on a full time basis to ensure success: those who cannot be spared by the business are the ones who are most likely to be required on the implementation. The team should be chosen based on their skills, past accomplishments, reputation and flexibility. This team should be entrusted with critical decision-making responsibility and ensuring that effective project plans (capable of finishing within time and budget) are designed and adhered to (Umble et al, 2003, pp245-246). The case study and survey investigations conducted by Motwani et al (2005, p541) and Soja (2006, p429) respectively, support the importance of team composition to ERP success.

Minimum customisation (B)

Nah et al (2001, p293) state that minimum customisation is required to take full advantage of the ERP system benefits. Gargeya and Brady's research (2005, p509) backs up this claim by finding that successful implementing firms have recognised the importance of streamlining their operations to allow them to implement a "vanilla" ERP version with minimum customisation. However, despite this, the research of Kumar et al (2003, p803) found that a large proportion

of implementing firms (65%) still made software modifications to their chosen ERP systems.

Performance evaluation (B)

Al-Mashari et al (2003, pp352-353) specify measuring and evaluating performance as a critical factor in ensuring ERP pay back. They state that performance measures should embody the whole organisation and capture tangible and intangible aspects of the impact of the ERP system. Umble et al (2003, p246) add that these measures should not only indicate how the system is performing, but must also be designed so as to encourage the desired behaviours by all functions and individuals (i.e. tied to individual compensation). Support for the importance of performance evaluation is detailed in the findings by Motwani et al (2005, p541) and Soja (2006, p427).

Effective communication (B)

Al-Mashari et al (2003, p359) describe communication as one of the most challenging, difficult and critical tasks in any ERP project. An effective communication program should cover several aspects including: managing expectations; keeping staff informed of project scope, objectives, activities and updates; and using middle management to highlight ERP importance to staff (Nah et al, 2001, p291). An example of the negative impact of poor communication on ERP success is highlighted through a case study conducted by Al-Mashari and Al-Mudimigh (2003, p30-31).

ERP package selection (B)

Al-Mashari et al (2003, p359) and Motwani et al (2005, p541) concur that the ERP system selected should best fit the current business processes of an organistation. By selecting the best-fit system, customisations are limited and the organisation is better enabled to take advantage of the ERP system benefits.

Software development, testing and troubleshooting (C)

Nah et al (2001, p294) write that the overall ERP architecture should be established before deployment, taking into account the most important requirements of the implementation. The importance of software development and configuration is supported by the research of Kumar et al (2003, p802) where 44% of surveyed respondents claimed that there ERP systems did not support the way the organisation worked thus impacting on the implementation. The testing and validation of the ERP system is regarded as important to ensure that the software works technically and that the business process configurations are practical (Al-Mashari et al, 2003, p361). Gargeya and Brady (2005, p513) found system testing to be a key element to the success of ERP systems.

Appropriate business and legacy systems management (C)

According to Nah et al (2001, p292) appropriate business and legacy systems are important in the initial chartering phase of the implementation, as they determine the IT and organisational change required for success. Al-Mashari et al (2003, p360) note that due to the complexity of dealing with multiple legacy systems, platforms and data sources, it is important that an organisation approaches the transition from legacy systems carefully and with a comprehensive plan. The research of Soja (2006, pp427-428) shows legacy system management to be regarded as moderately important to ERP success.

IT infrastructure (C)

Siriginidi (2000, p384-385) notes that appropriate IT infrastructure, including servers and a reliable Local Area Network (LAN) with adequate bandwidth, must be available during all phases of the implementation to ensure success. The difficulties of not having sufficient infrastructure in place (from standard printers to servers) is supported by the research of Kumar et al (2003, p802).

2.3.3 Summary of CSFs

This section of the research set out to investigate the CSFs required for a successful implementation, and hence the realisation of business benefits. Through conducting a review of the available literature, eleven articles focusing on ERP CSFs were selected. These articles were used to compile a consolidated list of CSFs, and to discuss their relative importance to ERP success. Through this review the research began to address the question:

What are the CSFs associated with ERP benefits being achieved?

However, due to the varied level of support for each CSF the review was unable to determine, with any degree of certainty, which are the most important CSFs. The review was also unable to establish an association between CSFs being in place and corresponding benefits being achieved.

2.4 Summary of the Literature Review Results and Findings

The literature review investigated the four key questions, asked when describing the purpose of the research, under three main sections:

1. Benefits of ERP Systems;
2. Organisational and ERP Performance Measurement; and
3. Critical Factors for ERP Success.

Section 2.1 Benefits of ERP Systems started off by identifying three main reasons for ERP adoption. These reasons for adoption were found to be linked to the expected benefits, established in investigating the question:

What are the benefits gained from ERP systems?

A summary of the expected ERP benefits findings was consolidated into Table 2.1. Although this table partially answers the question put forward (by identifying expected benefits), the degree to which the identified benefits are being achieved in implementing firms was not confirmed. The level of support for each benefit was also found to vary according to the international journals that were reviewed (no South African cases were found). These factors place doubt over the validity of the identified list, and therefore this question needs to be investigated further.

Section 2.2 Organisational and ERP Performance Measurement investigated the evolution of organisational and ERP performance measurement methods to determine a suitable measurement system for this study. Comparisons were drawn between organisational performance measurement and ERP performance measurement, and a list of criteria for an effective measurement system was compiled. Based on these criteria a number of ERP PMSs were evaluated and a modification of the ERP Scorecard (termed the ERP Time-Based BSC) was proposed as the most effective means of evaluating the impact of ERP systems within this study. As the ERP Time-Based BSC effectively links ERP performance to organisational performance it partially answers the question:

Is there a valid and reliable PMS that links ERP performance to organisational performance?

However, as the identified PMS remains a predominantly untested model (tested in part through previous BSC studies), its validity and reliability could not be confirmed.

The literature provided mixed results when investigating the question:

Do ERP systems have a positive impact on organisational performance in the time periods following implementation?

The ERP PMSs reviewed showed limited market testing and in cases provided conflicting results. Shang and Seddon (2002) and Chand et al (2005) identified the possibility of a positive impact on organisational performance by using a case study approach. However, when conducting a more comprehensive study Wieder et al (2006) found no significant performance difference between ERP adopters and non-adopters. Due to the lack of previous research, the conflicting findings discussed above, and the absence of research within the SA market, the above question was unable to be answered.

Section 2.3 Critical Success Factors for a Successful Implementation investigated the CSFs required for a successful implementation, and hence the realisation of business benefits. A review of the literature enabled a list of CSFs to be compiled which began to address the question:

What are the CSFs associated with ERP benefits being achieved?

However, due to the varied level of support for each CSF the review was unable to determine, with any degree of certainty, which are the most important CSFs. The review was also unable to establish an association between CSFs being in place and corresponding benefits being achieved.

3 METHODOLOGY

This chapter starts off by reviewing the literature findings to formulate the objectives for the research. Once the objectives and related hypotheses are defined, the methodologies for investigating the objectives and testing the hypotheses are discussed. The topic of "validity and reliability" is reviewed to ensure that meaningful conclusions can be drawn from the research. The methodologies adopted to investigate the objectives and test the hypotheses rely on a number of statistical tests to be performed. To add clarity to the testing procedure, the topics of: Cronbach's α, Statistical Significance and Linear Regression are discussed. The chapter then reviews the required sample frames and population/sample sizes, before concluding with the assumptions used for this research.

The research objectives and methodologies employed to investigate the objectives are summarised in Figure 3.1.

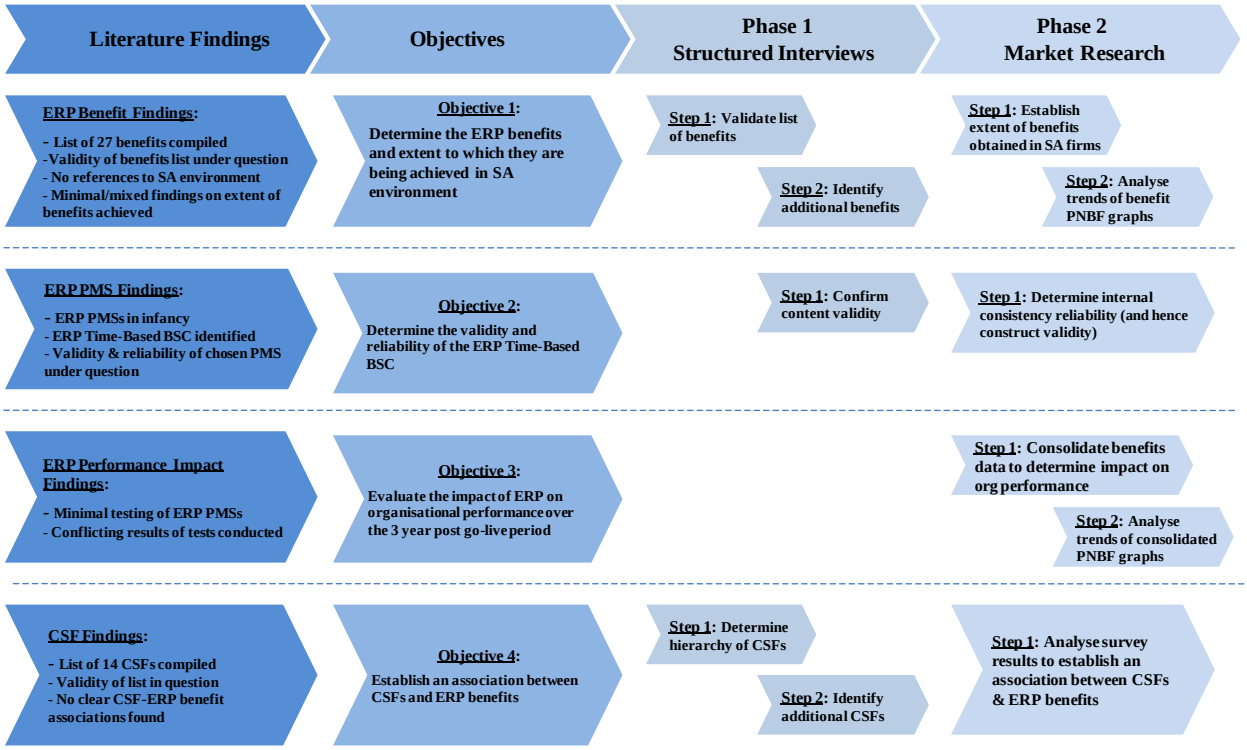


Figure 3.1 Research methodology

3.1 Literature Review Findings

The literature review set out to investigate the four key questions presented in section 1.3 (Purpose of the Research), namely:

1. Do ERP systems have a positive impact on organisational performance in the time periods following implementation?
2. Is there a valid and reliable PMS that links ERP performance to organisational performance?
3. What are the benefits gained from ERP systems?
4. What are the CSFs associated with ERP benefits being achieved?

To investigate these questions, the literature review began by conducting a review of ERP benefits. PMSs were then reviewed to determine if a suitable measurement system could be found to measure the impact of ERP systems on organisational performance. The degree of success in using these PMSs was investigated to determine if the ERP impact on organisational performance has been postulated (or already established) by previous work. Finally, CSFs were reviewed and discussed.

The findings of the literature review pertaining to the above questions are as follows:

What are the benefits gained from ERP systems?

Of the literature reviewed, ten articles were selected to conduct an in depth review of ERP benefits. Analysis of these articles enabled a list of 27 expected ERP benefits to be compiled. However, by using an "ABC" ranking system, it was shown that the level of support for the benefits varies. This variability in support raises doubt over the validity of the defined list. As this set of ERP benefits relates only to international studies (mainly European, Asian and North American), further doubt is cast over its validity within an SA environment as economic, social and political differences may influence certain benefits being achieved.

These factors indicate that further research is required to validate the list before it can be applied for further use in this study.

Regarding the degree to which benefits are being achieved: the review produced mixed results. Certain studies showed evidence of benefits being achieved, whereas other articles highlighted failed implementations where benefits were not realised. (It was noted that all these studies referred to international cases. No comprehensive SA cases were found.) No study was found to confirm the overall/average level to which benefits are being achieved by implementing firms. These findings indicate that there is a need for further research to determine the overall extent to which benefits are being achieved by implementing firms.

Is there a valid and reliable PMS that links ERP performance to organisational performance?

After reviewing organisational and ERP measurement systems, the ERP Time-Based BSC was assessed to be the most appropriate system for measuring the impact of ERP systems on organisational performance over time. However, as the ERP Time-Based BSC is populated with the list of 27 ERP benefits (still to be validated), the content validity of this PMS is put under question. As far as the construct validity of the PMS is concerned: it is assumed that as the chosen PMS follows the structure of the BSC (which has received wide application in research and business), the structure can be regarded as valid. However, as the four perspectives are populated with the benefits (identified through the literature review) based on the researcher's knowledge and judgement, the construct validity of the ERP Time-Based BSC needs to be further validated.

As the ERP Time-Based BSC is largely untested (only tested in ERP Scorecard format), the reliability of this PMS needs to be confirmed. This needs to be tested via the research.

Do ERP systems have a positive impact on organisational performance in the time periods following implementation?

The ERP measurement systems reviewed show limited market testing. Of the tests conducted, conflicting results were found (i.e. Shang and Seddon (2002) and Chand et al's (2005) results showing a positive impact, conflicted with the broader study conducted by Wieder et al (2006)). These conflicting results, combined with the general lack of research in this field (locally and abroad) resulted in the above question being unanswered through the literature review. Further work is therefore required to investigate the impact of ERP systems on organisational performance.

What are the CSFs associated with ERP benefits being achieved?

The literature review enabled a list of 14 CSFs to be compiled from the review of eleven selected articles. As in the case of the "benefits" review, the level of support for each CSF varied, casting doubt over the validity of the list, and necessitating further work to confirm the list for additional use in this study.

Although CSFs were discussed in the articles reviewed, none of the studies confirmed an association between CSFs being in place and individual ERP benefits being achieved. Consequently, the above question was unable to be answered through the review and remains a topic for further investigation.

3.2 Research Problem

The literature review enabled the questions behind the purpose of the research to be partially answered. However, further research is required to address all four questions. Combining the outstanding questions leads to the research problem for this study:

To determine the impact of ERP systems on organisational performance, by analysing achieved ERP benefits within the framework of a suitable PMS, and to investigate an association between CSFs and ERP benefits.

3.3 Research Objectives and Hypotheses

Breaking the research problem down into its sub-problems enables the objectives for the research to be determined. These objectives are defined in line with the sequence in which the research questions are investigated in addressing the central research problem.

The objectives and the associated research questions are summarised in Figure 3.2. (The central research objective is shown at the top of the pyramid).

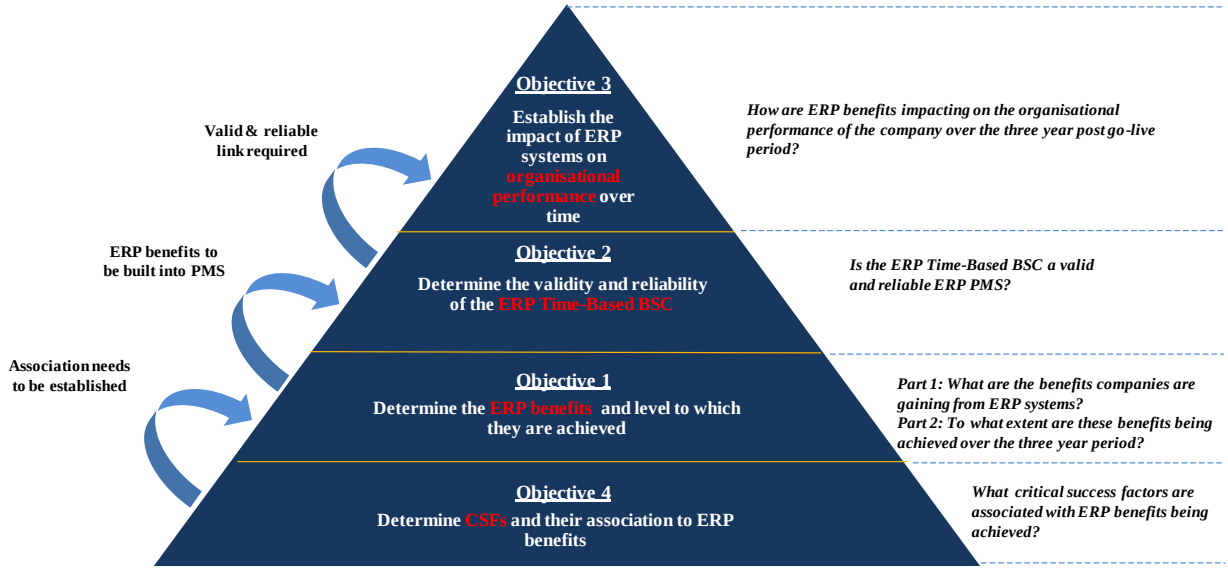


Figure 3.2 Objectives of the research

Firstly, the list of ERP benefits (defined through the literature review) needs to be validated and then applied to determine the level of ERP benefits that are being achieved within SA organisations. The first objective is therefore defined as:

Objective 1: To determine the benefits that SA manufacturing companies are gaining as the result of implementing ERP systems, and to gauge the level to which the benefits are being achieved.

Objective 1 is investigated through **Sub-Problem I**:
Part 1: What are the benefits that manufacturing companies are gaining as a result of implementing ERP systems?
Part 2: To what extent are benefits being achieved over the three year post "go-live" period?

The adopted hypothesis for this problem is **Research Hypothesis I**:
South African manufacturing firms are experiencing business benefits as a result of ERP implementations.

The second step is to determine the validity and reliability of the ERP Time-Based BSC for the purpose of evaluating the impact of ERP systems on organisational performance:

Objective 2: To determine the validity and reliability of the chosen ERP performance measurement system.

Objective 2 is investigated through **Sub-Problem II**:
Is the ERP Time-Based BSC a valid and reliable ERP PMS?

The adopted hypothesis for this problem is **Research Hypothesis II**:
The ERP Time-Based BSC is a valid and reliable ERP PMS.

Having determined the validity of the ERP benefits list, and hence the content validity of the ERP Time-Based BSC, the BSC structure can be populated with the ERP benefits data. Once the reliability of the ERP Time-Based BSC has been confirmed the primary research question can be investigated via Objective 3:

Objective 3: To evaluate the impact of ERP systems on organisational performance over time (taken to be the three year period post "go-live")

Objective 3 is investigated through **Sub-Problem III**:
How are ERP benefits impacting on the organisational performance of the company over the three year post "go-live" period?

The adopted hypothesis for this problem is **Research Hypothesis III**:
The benefits gained through ERP implementations have a positive impact on organisational performance over the three year post "go-live" period.

Through Objectives 1 to 3 the research aims to establish the impact of ERP systems on organisational performance, however the factors responsible for this impact still need to be determined. By validating the list of CSFs determined through the literature review, and linking the results to the benefits being achieved, these factors are investigated via Objective 4:

Objective 4: To determine the Critical Success Factors required for a successful implementation through their association with ERP benefits being achieved.

Objective 4 is investigated through **Sub-Problem IV**:
What CSFs can be associated with ERP benefits being achieved?

The adopted hypothesis for this problem is **Research Hypothesis IV**:
Common CSFs are associated with ERP benefits, and hence an increase in organisational performance, being achieved.

3.4 High Level Research Methodology

The review of the literature is extended to include a review of the methodologies used by previous research in addressing similar questions as those highlighted through the four objectives. This is done with the aim of clarifying the high level approach for this study. After reviewing the previous research methodologies, it has been decided that a two phased approach is required for this study:

Phase 1 consists of a series of structured interviews, with the aim of:

1. Validating the list of ERP benefits, and hence the ERP Time-Based BSC.
2. Identifying additional benefits not highlighted through the literature review.
3. Validating the list of CSFs and reducing it to a concise list of ten factors, to improve the survey response rate and avoid respondent fatigue in Phase 2.
4. Identifying any additional CSFs that should be included on the list.

Phase 2 involves conducting a market related survey with the aim of:

1. Determining the level to which ERP benefits are being achieved in the three year post "go-live" period.
2. Determining the reliability of the ERP Time-Based BSC.
3. Building the ERP benefits results into the ERP Time-Based BSC to determine the impact on organisational performance.
4. Establishing the extent to which CSFs have been in place during the surveyed ERP implementations.
5. Analysing the results to determine if an association can be established between the CSFs and ERP benefits.

The application of the two phased approach to investigating the individual objectives is discussed in more detail in sections 3.4.1 to 3.4.4:

3.4.1 Methodology for investigating Objective 1

A review of the literature on ERP benefits revealed that three main methods have been used in the past to quantify ERP benefits. Siriginidi (2000), Nah et al (2001), Chand et al (2005) and Poston and Grabski (2001) adopt a literature review and analysis approach to determine the ERP benefits that are being realised and should be expected. Sarkis and Sundarraj (2000), Mandal and Gunasekara (2003) and Davenport (1998) use a case study approach to investigate ERP benefits. Thirdly, Spathis and Constantinides (2003) utilize a survey approach. In evaluating these methods in relation to the current research, the case study approach is deemed to be ineffective for this study. This is due to the case study method providing detail of isolated cases, whereas the aim of this research is to relate the findings to the total population (therefore requiring a representative sample set to be used). Conducting a literature review in isolation to draw conclusions proved to be inconclusive as the research and documented ERP findings, particularly in a South African context, are sparse. A two phased approach is therefore adopted to investigate this objective:

Phase 1, structured interviews:

Step 1: Validate the benefits identified through the literature review (and there applicability to the SA market), especially in the case of the "C" items where literature support is weak.

Step 2: Identify additional benefits not highlighted through the literature review, but deemed to be of importance.

Phase 2, market research (using a survey approach):

Step 1: Establish the level to which benefits have been obtained by selected SA manufacturing firms, over the three year post "go-live" period. This is done by calculating the average benefits for the tested sample, to determine if benefits differ significantly from zero, on a year by year basis (refer to section 3.7 for notes on significance).

Step 2: Construct progress curves by building the average ERP benefit results into PNBF graphs (as used by Shang and Seddon, 2002) to determine if benefits can be expected to increase over time.

3.4.2 Methodology for investigating Objective 2

As the ERP Time-Based BSC is largely untested its validity and reliability needs to be established. Section 3.5 discusses the theory around "validity and reliability" and its relevance to this study. On the subject of content validity, one widely used method was developed by Lawshe (1975). Lawshe proposed using a group of subject matter experts to rate each item according to a Likert scale (showing levels of importance/usefulness). Due to the proven application of this method (Schriesheim et al, 1993), a similar approach is adopted in this research. When assessing the internal consistency reliability of an instrument, Gliem and Gliem (2003) advise the use of Cronbach's α in the case of multi-item Likert-type scales. Consequently the following approach is adopted to investigate this Objective 2:

Phase 1, structured interviews:

Step1: By validating the list of ERP benefits using a group of subject matter expects (through Objective 1), the content validity of the ERP Time-Based BSC is confirmed.

Phase 2, market research:

Step 1: Having confirmed the content validity of the ERP Time-Based BSC through the structured interviews, Cronbach's α is used to measure the internal consistency reliability of the PMS using the survey results (see section 3.6 for description of Cronbach's α). By measuring Cronbach's α the construct validity of the ERP Time-Based BSC is also established.

3.4.3 Methodology for investigating Objective 3

The studies reviewed on evaluating the impact of ERP systems from a balanced perspective (financial and non-financial measures) make use of either a single or multiple case study approach (e.g. Shang and Seddon (2002), and Chand et al (2005)), or a survey approach (e.g. Wieder et al (2006)). As discussed under the methodology for investigating objective 1, this study aims to relate findings to the total population. Following the same logic, the most applicable method for investigation objective 3 is through a market related survey:

Phase 2: market research:

Step 1: Consolidate the ERP benefits survey results into the four perspectives of the ERP Time-Based BSC (financial perspective, internal business perspective, customer perspective, learning & growth perspective), to determine if the consolidated results differ significantly from zero over the three year post "go-live" period.

Step 2: Construct progress curves in the form of PNBF graphs to display the consolidated effect of the ERP benefit results over the three year time period, and hence gauge the impact on organisational performance.

3.4.4 Methodology for investigating Objective 4

The literature focusing on ERP CSFs reveals that, as in the case of ERP benefits, three main research approaches have been adopted by previous researchers: Nah et al (2001), Gargeya and Brady (2005), and Al-Mashari et al (2003) adopt a literature review and analysis approach to draw conclusions surrounding CSFs. Umble et al (2003) and Motwani et al (2005) utilize a case study approach to investigate the key CSFs. Kumar et al (2003) and Soja (2006) conduct their research by making use of market questionnaires and structured interviews.

The above review indicates that the method chosen for investigating the ERP benefits for this study is also applicable in investigating the CSFs. These findings, together with the need for consistency in the research approach have led to the following methodology being favoured for the investigation into the association between CSFs being in place and business benefits being achieved:

Phase 1, structured interviews:

Step 1: Determine a hierarchy of the CSFs identified through the literature review, as a means of validating the literature findings and enabling a concise and focused list to be used in the market research.

Step 2: Determine if there are any additional CSFs that should be added to the identified list.

Phase 2, market research:

Step 1: Establish the extent to which CSFs have been in place during the surveyed ERP implementations.

Step 2: Test for an association between CSFs being in place and benefits being achieved. (Linear regression, described in section 3.8 has been used for this purpose.)

3.5 Validity and Reliability

The validity and reliability of the measuring instruments (together with the chosen research method) influence the extent to which something can be learnt from the phenomenon being studied, the probability that statistical significance will be obtained in the data analysis, and the extent to which meaningful conclusions can be drawn from the data (Leedy and Ormrod, 2005, p27). This section discusses the theory with respect to the validity of the methodology adopted for the research as well as the validity and reliability of the instruments used. It relates the theory to the practical application for this study.

3.5.1 Validity of the chosen method

Validity of the chosen method refers to the accuracy, meaningfulness and credibility of the research project as a whole. It can be broken down into internal validity and external validity.

Internal validity of a research study is the extent to which its design and the data it yields allow the researcher to draw accurate conclusions about relationships within the data. It seeks to establish that the changes in the dependent variable are the result of the influence of the independent variable, instead of the manner in which the research was designed (Leedy and Ormrod, 2005, p97).

By following a detailed interview procedure (Phase 1) this research aims to ensure the internal validity of the market research (Phase 2). This is achieved by determining the validity of the chosen measurement instrument (ERP Time-Based

BSC), as well as the list of CSFs. Further, by validating the list of benefits and CSFs (established through literature review) a framework can be setup to investigate the effect of the independent variable (CSF) on the dependent variable (benefit).

External validity of a research study is the extent to which its results apply to situations beyond the study itself – in other words, the extent to which the conclusions drawn can be generalized to other contexts (Leedy and Ormrod, 2005, p99).

The market research targets a wide range of manufacturing companies across SA. Through the diversity in response sources, the research aims to suggest generalisations about the entire population.

3.5.2 Validity of measurement instruments

The **validity** of a measurement instrument is the extent to which the instrument measures what it is supposed to measure (Leedy and Ormrod, 2005, p28).

Leedy and Ormrod (2005) divide validity into four main categories:

1. **Face validity** is an estimate of whether a test appears to measure a certain criterion; it does not guarantee that the test actually measures the phenomena in that domain (Leedy and Ormrod, 2005, p92). Face validity is commonly used to encourage the participation of individuals within a research study.

   In constructing the interview and market research questionnaires within a framework that is familiar to most business professionals (i.e. the Balanced Scorecard), the research aims to increase the face validity and hence the response rate to the interviews and market related survey.

2. **Content validity** is the "extent to which a measurement instrument is a representative sample of the content area (domain) being measured" (Leedy and Ormrod, 2005, p92). It is established by showing that the test items are a sample of a universe in which the investigator is interested (Cronbach and Meehl, 1955, p282).

   As there is doubt over the content validity of the benefits and CSF lists, a series of interviews with subject matter experts are conducted. This enhances the content validity of the ERP Time-Based BSC and the subsequent associations that are investigated between CSFs and ERP benefits.

3. **Criterion validity** "is the extent to which the results of an assessment instrument correlate with another, presumably related measure". (Leedy and Ormrod, 2005, p92). There are two types of criterion validity: concurrent validity and predictive validity.

   Concurrent validity refers to the degree to which the operationalization correlates with other measures of the same construct that are measured at the same time (Trochim, 2006). For example, a new test for intelligence would have concurrent validity if the correlation between it and accepted IQ tests were positive.

   Predictive validity refers to the degree to which the operationalization can predict (or correlate with) other measures of the same construct that are measured sometime in the future (Trochim, 2006).

   The concurrent validity is not established due to time and resource limitations of the research. By relating findings to the total population, the aim is to increase the predictive validity of this study. However, this will only be able to be confirmed through future research as recommended in Chapter 8.

4. **Construct validity** "is involved whenever a test is to be interpreted as a measure of some attribute or quality which is not operationally defined" (Cronbach and Meehl, 1955, p282). Leedy and Ormrod (2005) add to this definition by stating it is the extent to which an instrument measures a characteristic that cannot be directly observed but must instead be inferred. There are two approaches to construct validity: convergent validity and discriminant validity.

   Convergent validity refers to the degree to which a measure is correlated with other measures that it is theoretically predicted to correlate with (Hatcher, 1994).

   Discriminant validity describes the degree to which a measure does not correlate with measures that it should theoretically correlate with (Hatcher, 1994).

   Although the BSC has been validated through multiple studies, for example Kaplan and Norton (1992), the construct validity of the ERP Time-Based BSC needs to be further investigated as the four perspectives have been populated with the benefits based on the researcher's own knowledge and judgement. To achieve this, the construct validity (convergent validity) is tested by using Cronbach's α to measure the internal consistency reliability of the instrument.

3.5.3 Reliability of measurement instruments

The **reliability** of a measurement instrument "is the extent to which it yields consistent results when the characteristic being measured hasn't changed" (Leedy and Ormrod, 2005, p93). Leedy and Ormrod point out that validity is not a condition of reliability, but reliability is a necessary but insufficient condition of validity. Reliability can take several forms, including interrater reliability, internal consistency reliability, equivalent forms reliability, and test-retest reliability (Leedy and Ormrod, 2005, p93):

1. **Interrater reliability** is the extent to which two or more individuals evaluating the same product or performance give identical judgments.

2. **Internal consistency reliability** is the extent to which all the items within a single instrument yield similar results, i.e. the extent to which all parts of measuring instrument are measuring the same thing.
3. **Equivalent forms reliability** is the extent to which two different versions of the same instrument yield similar results.
4. **Test-retest reliability** is the extent to which the same instrument yields the same result on two different occasions.

Due to the nature of the study (a single researcher, using a single instrument) interrater reliability and equivalent forms reliability is not tested. The test-retest reliability of the ERP Time-Based BSC is not tested due to the time involved weighed up against the perceived benefit from performing the required tests. However, as this is the first time the ERP Time-Based BSC is being used it is deemed essential to confirm the internal consistency reliability of the measurement instrument. To test this reliability, Cronbach's α is calculated.

3.6 Cronbach's Alpha

"Cronbach's α is the average value of the reliability coefficients one would obtain for all possible combinations of the items when split into two half tests" (Gliem and Gliem, 2003, p84). It is commonly used to measure the internal consistency reliability of an instrument. Cronbach's α measures how well a set of variables or items measures a single, unidimensional latent construct.

Cronbach's α is calculated as the average of the correlations of all the possible ways of dividing a test into two sets. The formula for Cronbach's α (Hatcher, 1994) is given by:

$$\propto = \left(\frac{N}{N-1}\right) \times \left(1 - \frac{\sum {S^2}_i}{{S^2}_{sum}}\right) \quad (3.1)$$

Where:

α = Cronbach's coefficient alpha

N = number of items constituting the instrument

$S^2{}_i$ = variances of the N individual items

$S^2{}_{sum}$ = variance of the sum of all items

Cronbach's α reliability coefficient normally ranges between 0 and 1 (Gliem and Gliem, 2003). However, there is actually no lower limit to the coefficient. The closer Cronbach's α is to 1 the greater the internal consistency of the items in the scale.

3.7 Hypothesis Testing and Statistical Significance

"A research hypothesis exists because the research problem or the sub-problems issuing from it arouse curiosity in the researcher's mind; this arousal, in turn leads to a tentative guess about how to resolve the problem situation" (Leedy and Ormrod, 2005, p270). The research hypothesis can therefore be described as a reasonable conjecture, or educated guess. In testing the observed data we aim to establish if the hypothesis is valid or if the result observed is by chance alone. (A null hypothesis postulates that any result observed is the result of chance alone.)

A significance level is chosen as the cut-off point at which the research claims that the results are not the result of chance. Put another way, significance shows our confidence in the results. A result is "statistically significant" if it is unlikely to have occurred by chance.

Leedy and Ormrod (2005, p271) state that if the research concludes that a result was not due to chance when in fact it was due to chance, it is described as a Type I (or alpha error). Similarly, a Type II (or beta) error occurs if it is concluded that a result is due to chance when in fact it was not.

3.8 Linear Regression

Linear Regression is used to establish an association between the Dependent Variables (DV) and the Independent Variables (IV). (Within this study, the benefits are the DVs and the CSFs the IVs.) Regression is used to understand

which of the independent variables are associated with the dependent variables, and to explore the nature of the associations.

The least squares method is commonly used to calculate a straight line that best fits the data (Fox, 1997). Taking y_i as the dependent variables and x_i as the independent variable (where $\bar{x}$ and $\bar{y}$ are the means of the *x* and *y* values respectively, and i = 1...n observations) the equation for the regression line is defined as:

$$y_i = B_0 + B_1 x_i + \text{error} \tag{3.2}$$

Where:
B_0 is a constant (intercept),

$$B_0 = \bar{y} - B_1 \bar{x} \tag{3.3}$$

and
B_1 is the slope (indicating the strength and direction of the association),

$$B_1 = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sum(x_i - \bar{x})^2} \tag{3.4}$$

"error" captures the amount of DV variance not explained by the IVs,

$$error = \sqrt{\frac{1}{(n-1)}\left[\sum(y_i - \bar{y})^2 - \frac{[\sum(x_i - \bar{x})(y_i - \bar{y})]^2}{\sum(x_i - \bar{x})^2}\right]} \tag{3.5}$$

Whereas "error" captures the amount of DV variance not explained by the IVs, the Coefficient of Determination (R^2) answers "how much of the DV variance did our model explain?" To define R^2 another way, "R^2 is the proportion of variability in a data set that is accounted for by the statistical model" (Steel and Torrie, 1960). R^2 is calculated as the square of the sample correlation coefficient (r), where:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}} \quad (3.6)$$

Resulting in:

$$R^2 = \left[\frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}\right]^2 \quad (3.7)$$

By calculating R^2 the regression fit ("how well are future outcomes likely to be predicted by the model?") can be determined. R^2 ranges from 0-1, indicating the percentage of the variance that can be explained by the regression line. Ratner (2009) recommends the following as acceptable guidelines for evaluating *r* and hence R^2:

Table 3.1 Goodness of fit guide

Value of r	Corresponding value of R^2	Goodness of fit
-0.3 to 0 & 0 to 0.3	0 to 0.09	weak
-0.3 to -0.7 & 0.3 to 0.7	0.09 to 0.49	moderate
-0.7 to -1 & 0.7 to 1	0.49 to 1	strong

This guideline is accepted for this study.

3.9 Sampling Frame for Phase 1

The information required has been identified as residing within the knowledge of the SA workforce who have been involved with ERP system implementations and their application. This population consists of ERP system design and implementation experts, as well as ERP business users:

1. ERP system design and implementation experts – this group consists of those individuals who purpose design and facilitate the implementation of ERP systems. These individuals must have a detailed understanding of the technical setup and functionality of an ERP system to achieve the required benefits. They must also have a broad knowledge base of implementations conducted in South Africa. Consequently, this group consists of experienced software vendors and consultants.

2. ERP business users – this group is made up of those individuals who work with ERP systems within a manufacturing organisation and focus much of their time on using ERP systems to add value to their organisations. This group should have firsthand experience of the benefits and pitfalls of working with ERP systems. This group is made up of executives and senior managers in roles focusing on business optimisation, aided by the use of technology.

3.10 Population and Sample Size for Phase 1

The required data consists of industry feedback regarding the applicability of ERP benefits and CSFs. Sufficient data are required to complement the information obtained through the literature review to either validate or rule out the possibility of certain benefits and CSFs.

Out of the articles discussed in the literature review, ten articles were chosen as the foundation for the benefits matrix shown in Table 2.1. To check the validity of the articles, ten local respondents are targeted for the interview process. This sample size will enable feedback to be obtained from experts and business users in multiple organisations with varied experience. By adopting this sample size the interview process is predicted to produce an accurate reflection of the market perception whilst minimizing the risk of bias in the feedback.

It is virtually impossible to estimate the total population of ERP experts and business users in the market, sufficient to say that it would number into the thousands (at least), and therefore obtaining ten qualified individuals to participate in the interviews should not pose a problem.

3.11 Sampling Frame for Phase 2

The frame for this phase consists of South African manufacturing companies who have implemented ERP systems from one of the main software vendors (e.g. SAP, Oracle, Peoplesoft). As many of the software vendors offer a range of

implementation options, including available modules, functionality, "lite" versions etc, the distinguishing factor will not be based on the brand of ERP implemented but rather on the size of the implementing organisation. It is assumed that an organisation with a revenue of greater than R300 million (taken as a guide from Financial Mail, 2008) will require a fully functional ERP. The sampling frame is therefore defined as:

South African manufacturing companies, with a revenue of greater than R300 million per annum, with ERP systems in place.

3.12 Population and Sample Size for Phase 2

A literature search was conducted of recent journal articles and relevant internet sites to determine if a comprehensive list of South African manufacturing companies who have implemented ERP systems could be found. Organisations dealing with industry statistics (for example, Statistics South Africa and the Department of Trade and Industry) were also contacted. No such lists were found, necessitating that a more investigative approach be adopted to estimate the population size and hence determine and appropriate sample set.

The investigative approach that was decided on is:

Step 1: Contact the leading ERP vendors to request a list of ERP customers, with contact details of the appropriate senior managers/executives. By having a recommended contact the aim is not only to ensure that the questionnaire is sent to the most suitable person in the organisation, but by stating the vendor as the source it is hoped that these existing relationships can be used to increase response/participation rates.

Step 2: Failing "step 1", contact the main ERP implementers and consultancies to request a list of their past implementations and client contact details.

Step 3: Compare the list of companies identified in "steps 1 and 2" to the total number of manufacturing companies in SA that fit the profile for having an ERP

system in place (judged on size/revenue). This step will enable the researcher to estimate the total population size and hence the required sample size.

Step 4: If the sample size is deemed not to be sufficient, those manufacturing companies identified in "step 3" as fitting the requirements for having an ERP system are to be contacted via a "cold calling" process to establish if they have an ERP system in place and who the appropriate person would be to take part in the survey. However, this approach is only to be used as a last resort as it is anticipated to yield minimal feedback, due to amongst other factors the knowledge and willingness of the companies' switchboard operators to put the researcher in touch with the appropriate people.

The procedure as described above was followed with the following results:

Step 1: South Africa's **three leading ERP vendors** were contacted by telephone. Once the objectives of the study were explained, and the researcher expressed a willingness to share results with the vendors, a list of their ERP clients was requested. In all three cases the researcher was informed that the information requested was confidential and all three vendors declined the request to supply the data.

Step 2: **Four top management consultancies**, involved with ERP implementation/post-implementation work, were approached in person and the same request as in "step 1" was presented to them. The results of the requests were as follows:

1. In one case the consultancy said they were not able to give out the requested information.
2. In two cases the consultancies were able to supply a comprehensive list of clients, and potential clients, where ERP systems were in place. However, although the appropriate person in each organisation was identified, both consultancies requested not to be quoted as the source of providing contact information.

3. In one case the consultancy was able to supply a limited list of companies and contact persons (five in total), and was comfortable with the researcher quoting them as the source of information and leveraging the existing relationship with the client.

To further build up the sample set, the researcher approached **three major corporations**, to determine if a list of their suppliers/customers with ERP systems in place could be provided with contact details. The corporations were willing to assist by supplying a list of their top customers and suppliers with ERP systems in place, together with the appropriate contact details. The corporations granted permission for the researcher to leverage their existing relationship with the customers/suppliers to encourage a higher response rate.

Step 3: Step 2 led to a list of 79 companies being identified (see Appendix A: Market Research Population and Sample Set), with relevant contact people being identified at each company. (In 30 of the 79 cases the researcher was permitted to mention an existing client relationship). However, as this list was built up by limited input, it cannot be considered to be a comprehensive list of the total ERP implementations in the manufacturing sector in SA. To gain a feasible estimate of the population size this list was compared to two sources of information:

1. The Financial Mail's list of SA Giants (Financial Mail, 2008) which shows the top 200 listed SA companies by revenue for the 2007 financial year. (This list is shown in full in Appendix A: Market Research Population and Sample Set, and will be referred to in this research as the Financial Mail's "Top 200 list".) The Financial Mail's Top 200 list was deemed to be the best available reference as it includes all the Johannesburg Stock Exchange (JSE) listed firms with an annual revenue of ~R300 million upwards. However two factors that must be taken into account when using this list as a reference are:
    a. The Top 200 list does not include manufacturing companies with an annual turnover of less than R300 million. However, this is not deemed to be a major factor because as previously stated, only a

limited number of companies of this size would be expected to have invested in a full main stream ERP system.

b. The list does not cover the multi-nations with local operations (or other manufacturing organisations) not listed on the JSE.

2. To address point 1.b, statistics were obtained (Statistics South Africa, 2008) summarising the total number of SA manufacturing firms with a revenue of greater the R300 million per annum. This list shows that there are 261 manufacturing companies which fit into this category (Appendix A: Market Research Population and Sample Set).

When compared to the Financial Mail's Top 200 list, it can be seen that 42 of the 77 "Top 200" manufacturing firms (55%) are contained in the sample list of 79 companies. At this stage the researcher is unable to confirm whether or not the remaining 35 manufacturing companies on the Top 200 list have ERP systems in place, but what can be stated with confidence is that the sample list includes at least 55% of manufacturing companies listed on the JSE with ERP systems in place. Extrapolating these findings, it is estimated that the sample list of 79 covers approximately half of all major ERP implementations in the manufacturing sector in South Arica, leading to a maximum population size of approximately 160 out of a potential 261 companies. Gay and Airasian (2003, p113) recommend that for a population size of around 500 or less at least 50% of the population should be sampled. Following this recommendation it has been decided to use the total sample list of 79 companies as the sample set. As this sample set is estimated to be approximately half of the total population it is deemed to be sufficient for the study.

Step 4: As the sample set is deemed to be sufficient through step 3, a "cold calling" procedure to contact the remaining companies on the Top 200 list was not conducted.

3.13 Data Collection and Assessment

The data collection and assessment methodologies adopted for Phase 1 and Phase 2 are discussed in detail in Chapter 4 and Chapter 5 respectively.

3.14 Assumptions

Considering the literature findings and chosen methodology, the following assumptions are made for this study:

The first assumption is that because the ERP systems from the main stream software vendors (namely, SAP, Oracle, PeopleSoft and JD Edwards) have a feature overlap of approximately 60-70% (Gupta and Kohli, 2004, p3) and aim to achieve common business benefits, the research findings are by enlarge independent of the brand of ERP system implemented.

The second assumption is that only a limited number of companies with an annual revenue of <R300 million will be able to invest in a main stream ERP system. However, it is recognised that excluding such companies could lead to possible bias in the results.

The third assumption is that results can be combined across industries within the manufacturing sector.

The fourth assumption is that sample feedback obtained will be applicable to the whole of the SA manufacturing sector.

The fifth assumption is that the demand for ERP implementations and improvement initiatives will continue over the years to come, validating the reasons for this study.

The sixth assumption is that the total population for the market research consists of approximately 160 companies.

3.15 Summary of Methodology

Through reviewing the findings from the literature review, four objectives for the research were defined. Hypotheses were defined in line with the objectives, and a two-phased methodology for investigating the objectives and testing these hypotheses was discussed. To ensure the validity and reliability of the research a number of statistical tests were described. These tests are performed in the subsequent chapters using data collected from the two populations defined in this chapter. This chapter concluded by listing the assumptions for the research.

4 METHODOLOGY & RESULTS: STRUCTURED INTERVIEWS

The literature review enabled base lists of expected ERP benefits and CSFs to be constructed. However, two weaknesses were observed with these lists:

1. In many cases the literature support was found to be weak and often conflicting (especially in the case of "C" benefits and CSFs).
2. None of the literature reviewed focuses on the South African environment. The point could be argued that this is not a major factor as ERP systems should have the same benefits and CSFs regardless of the location of implementation. However, the counter argument could be that the social, economic and political climate within SA can potentially lead to a variation on the benefits that are realised and the CSFs that need to be in place.

This section of the research attempts to address these identified weaknesses by validating the literature defined lists of benefits and CSFs within the SA environment. As most of the information required resides within the knowledge of the local ERP experts and business users, the method adopted for obtaining this information is through a structured interview process as described by Leedy and Ormrod (2005, p184).

The results of the interviews are analysed to confirm the benefits and CSFs that are most relevant to this study. By validating the identified list of ERP benefits a confirmed list of expected benefits is defined. This list assists with addressing Objective 1 through building on part 1 of Sub-Problem 1, i.e.:
What are the benefits that manufacturing companies are gaining as the result of implementing ERP systems?

By investigating the list of CSFs further, a concise list of factors is confirmed to be used in the market research to test Sub-Problem IV:
What CSFs can be associated with ERP benefits being achieved?

4.1 Objectives of the Structured Interviews

The interviews were conducted with the following objectives in mind:

1. Validate the benefits identified through the literature review, especially in the case of the "C" items where literature support is weak.
2. Identify additional benefits not highlighted through the literature review, but deemed to be of importance.
3. Determine a hierarchy of the CSFs identified through the literature review, as a means of validating the literature findings and enabling a concise and focused list to be used in the market research.
4. Determine if there are any additional CSFs that should be added to the identified list.

4.2 Interview Methodology

The interviews were conducted in line with the research methodology described in Chapter 3, highlighted in Figure 4.1.

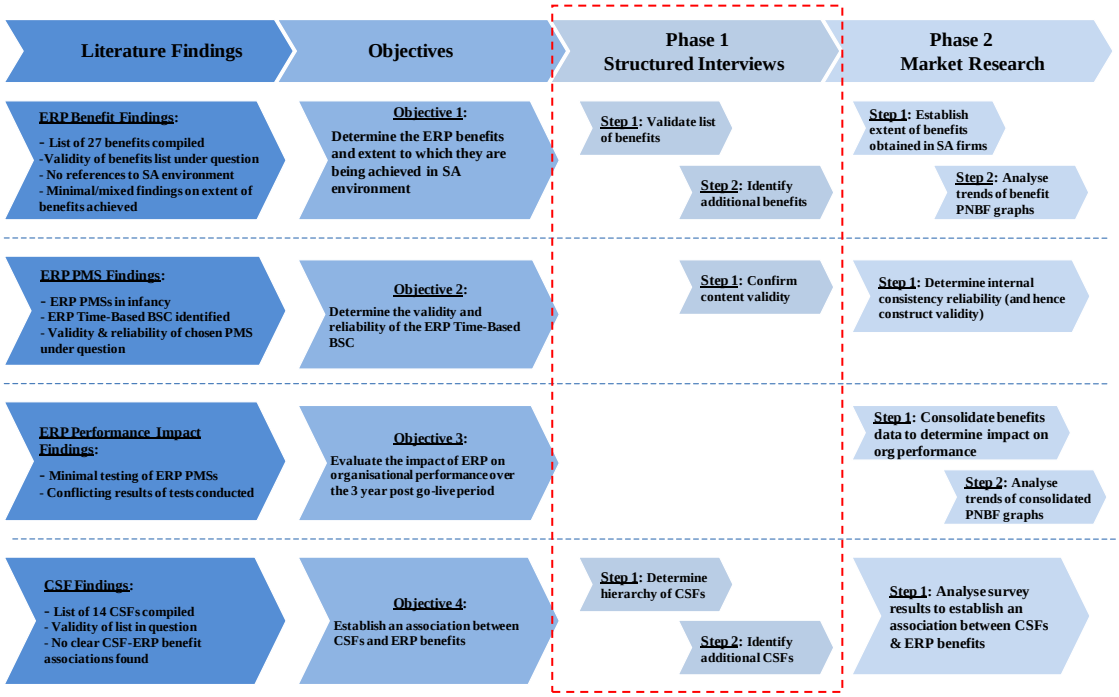


Figure 4.1 Research methodology (Phase 1)

The data collection and assessment methodologies for this phase of the research are discussed in detail in sections 4.2.1 and 4.2.2:

4.2.1 Data collection methodology

Data needed

The data that is needed consists of feedback regarding the validity of the benefits and CSF lists that were compiled through the literature review. Sufficient data is required to enable a thorough assessment of the respective lists to take place. As discussed in section 3.10, feedback from at least ten sources is required to allow for an equal weighted comparison to take place with the literature findings (where ten articles are reviewed).

Data location

As the documentation within a South African context is assessed to be fairly sparse, and/or distributed across multiple company records and archives, the most comprehensive source of information is assessed to be the SA ERP business experts and users themselves. As the bulk of the SA economic activity takes place in the Central Gauteng region, the majority of the top software vendors, consulting companies and manufacturing head offices are based in this region. It is therefore deduced that most of the ERP experts and top end business users reside in this region. As the researcher also resides in this region, this facilitates the use of face-to-face interviews as a means of gathering the data.

The author weighs the opinions and feedback of ERP experts and business users equally, so following the fore-mentioned logic, five ERP experts and five business users are targeted for the interview sessions.

Instrumentation

The purpose of this section of the research is to validate and expand on the lists of pre-determined ERP benefits and CSFs. Due to the location of the data, and the need for statistical evaluation of the results, the optimal instrument for this purpose is deemed to be a quantitative questionnaire to be completed via a structured interview process. The questionnaire needs to consist of Likert scales as recommended by Lawshe (1975) to enable the content validity of the lists to be effectively determined. By adopting an interview process, the researcher is able to

address any questions the participants may have, as well as explore in depth with the participants areas where the literature is weak.

The interview methods available for this process could either take the form of telephone interviews or face-to-face interviews. As face-to-face interviews promise to yield the highest response rate (Leedy and Ormrod, 2005, p184), and the majority of ERP experts are assessed to reside in the Central Gauteng region (same region as researcher) the later approach is adopted.

The **design of the interview questionnaire** focuses on two main objectives:

1. Produce a format to enable local experts to evaluate the ERP benefits and CSFs identified in the literature review.
2. Facilitate the identification of additional ERP benefits and CSFs.

To achieve these objectives the research defines a list of design requirements, used as a guide to compile a draft questionnaire. The draft questionnaire is then tested via a pilot study.

The **pilot study** sets out to test the questionnaire in an interview format. As the interviews target both business users and implementation experts, the questionnaire is tested at two levels. Firstly, an ERP business user is interviewed, and secondly an ERP consultant evaluates the questionnaire and interview format. The pilot study produces a number of findings, enabling the interview questionnaire to be modified for the full study.

The **questionnaire design** and **pilot study** are described in detail in Appendix B: Structured Interview Questionnaire Design.

Securing the data

Appropriate interview candidates were identified via the researcher's links to the local ERP community. Once the appropriate participants had been identified the following process was followed to contact the participants and secure the data:

1. The identified participants were contacted in person, via telephone conversations or personal visits, to ask for their participation in the research.
2. Once agreement to participate was received, a meeting request was emailed out for an agreed date and time.
3. An agenda of questions was sent via email to the interviewees prior to the interview.
4. It was requested of the interviewees that all interviews be tape recorded to ensure a verifiable record of the questions and responses.
5. Dates and times for the interviews were confirmed in writing.
6. Interviews were scheduled for a duration of 1 hour, and followed a standard format:
    a) The researcher provided the respondent with a 5-10 minute overview of the research and answered any questions the respondent had.
    b) The researcher then went through the three sections of the questionnaire with the respondent, taking down his/her answers and noting any key comments (time 40-45 minutes).
    c) The researcher concluded the interview by summarising the responses and thanking the respondent for his/her participation.
7. Following the interview the researcher summarised the tape recorded interview using the appropriate comment fields on the questionnaire. This written transcript was then sent to the interviewee for verification and correction where applicable.

4.2.2 Data assessment methodology

The data are analysed and interpreted using the following methodology:

Determine the nature of the data

To establish the statistical measurements to be used in analysing the data, the nature of the data first needs to be established:

As the ERP benefits rating scale on the interview questionnaire is designed to reflect equal (and discrete) units of measurement (ranging from -3 to 3), and a zero point has been established arbitrarily, the data obtained can be described as being interval in nature. Because the data are on an interval scale the use of parametric statistics is considered as a means to provide the most comprehensive analysis. However, because parametric statistics assume that the data fall in a normal distribution, the distribution of the data needs to be verified to determine the most applicable statistics.

The CSF data differs in nature from the benefits data due to the ordinal scale that is used to rank the CSFs. By using this measurement scale the degree of difference between each CSF cannot be confirmed as being equidistant and hence the methods of evaluating the ERP benefits data and CSF data may differ.

Identify descriptive statistics

Two sets of measures are considered when analysing the data, namely measures of central tendency (or location) and measures of variability. A measure of skewness is applied to establish the distribution of the ERP benefits data and determine which measures within the fore-mentioned sets are most applicable to the data.

Measure of central tendency. Since the ERP benefits data was collected on an interval scale the use of the arithmetic mean, mode and median is considered to determine the point of central tendency. If the data are normally distributed, the mean is favoured as the point of central tendency. However, if the data are skewed

the use of the median is favoured. Using the mode is considered as a last option if the spread of the data are in such a way as to minimise the effectiveness of the mean and the median (i.e. multimodal distribution).

Leedy and Ormrod (2005, p258) state that it only makes mathematical sense to compute an average (mean) when the numbers reflect equal intervals along a particular scale. Since the CSF data cannot be represented along an equal interval scale the mean is not considered as an appropriate measure of central tendency. Instead the ordinal nature of the data favours the mode or the median as a more appropriate measure.

Measure of variability. For a normal distribution of the ERP benefits data, the range and standard deviation are considered. However, if the data are skewed the use of the interquartile range or, standard deviation in conjunction with a measure of skewness, is favoured.

The range and interquartile range are considered when analysing the spread of the CSFs data.

Measure of skewness. The degree of skewness assists in determining the measures of central tendency and variability that are most applicable for the ERP benefits data analysis.

Skewness refers to the asymmetry of a distribution. A distribution with an asymmetric tail extending to the right is referred to as “positively skewed”, and a distribution with an asymmetric tail extending to the left is referred to as “negatively skewed” Wuensch (2005, p1855).

A measure of skewness was first proposed by Karl Pearson in 1895 (Pearson, 1895). Pearson defined this measure as the difference between the mean and the mode, divided by the standard deviation:

$$sk = \frac{(mean - mode)}{\sigma} \quad (4.1)$$

Population modes are not effectively estimated from sample modes, but the difference between the mean and the mode can be estimated as being three times the difference between the mean and the median (Stuart and Ord, 1994), leading to the following estimate of skewness being established:

$$sk_{est} = \frac{3(mean - median)}{\sigma} \quad (4.2)$$

Wuensch (2005, p1855) states that many statisticians use this measure, but with the '3' eliminated, i.e.:

$$sk = \frac{(mean - median)}{\sigma} \quad (4.3)$$

Wuensch (2005) continue to describe that skewness has also been defined with respect to the third moment about the mean. Skewness measured in this way is often termed "Fisher's skewness". Durrans (1994, p155) states that this is by far the most commonly accepted way of estimating the skewness of a sample population. Fisher's skewness is defined as:

$$G = \frac{n}{(n-1)(n-2)} \sum \frac{(x_i - \bar{x})^3}{\sigma^3} \quad (4.4)$$

Where:
G = Fisher's Skewness
n = number of variables in the sample population
$\bar{x}$ = sample mean
σ = standard deviation

If the sample population is normally distributed the skewness will be zero. The further the results stray from zero, the greater the skewness. A positive value indicates a positively skewed distribution and a negative value a negatively

skewed distribution. Brown (1997, p16) states that the level of Fisher's skewness becomes significant at two standard errors of skewness (*ses*) (using the absolute difference). For large sample sizes (n > 150), Tabachnick and Fidell (1996) specify the following formula for estimating the *ses* :

$$ses = \sqrt{\frac{6}{n}} \tag{4.5}$$

Where:

n = number of variables in the sample population

Application of descriptive statistics to the data

The chosen measures of central tendency and variability are applied to the data obtained for each ERP benefit and CSF to enable a detailed analysis to take place.

4.2.3 Results analysis methodology

As in the literature review, an "ABC" classification method is applied to the ERP benefits data to rank measures according to the interview feedback. This classification is combined with the literature classification to determine an overall classification for each benefit. This overall measure is used to establish if each benefit should be included in the market research, by applying the following rules:

1. "A" classification benefits have either been sufficiently validated through both the literature research and the interview data, or where the literature was weak have been strongly supported by the interview data. Therefore, all these benefits are included in the market research.
2. "B" classification benefits have received moderate support from the literature and/or interviews. The data for these items, including the comments obtained through the interview process, is analysed more closely to determine whether or not these benefits should be included in the market research.

3. "C" classification benefits have received little support from both the literature and interview data. Consequently, these benefits are considered to be of minor importance and are left out of the market research.

A detailed description of the above classification process, including the logic behind it, is presented in Appendix C: ABC Classification.

The additional ERP benefits, identified through the interviews, are analysed to determine if there is sufficient support for including these benefits in the market research.

The CSF data is ranked in ascending order using the chosen measure of central tendency. In the case of two or more CSFs having the same value of central tendency, the CSF with the lower measure of variability is ranked higher. The variability of the data, in conjunction with the interviewee comments and literature support, is then reviewed to confirm if the ordered list is an accurate reflection of the interview feedback or if there is justification for altering the list. The top ten ranked measures are used in the market research.

4.3 Interview Results

4.3.1 Interview response

Twelve ERP experts were contacted, of which ten (the targeted sample size) agreed to be interviewed. The ten interviews were conducted using the procedure for securing the data described in section 4.2.1. In all cases the respondents had reviewed the questionnaire prior to the interview session and all interviewees granted permission for the interviews to be tape recorded (a summary of each interview is presented in Appendix D: Structured Interview Transcripts, with consolidated results provided in Appendix E: Consolidated Interview Responses).

The sample set consisted of:

1. the senior managers from the two software vendors;
2. three management level consultants with a wide range of ERP experience; and
3. five senior managers and directors form three different manufacturing organisations.

Due to the positive response from one organisation in particular, and the depth of knowledge that was found within that organisation, three respondents were chosen from this organisation. The varied experience that these three individuals have acquired across multiple SA organisations is expected to add much value to the interview process and the fact that they now reside within the same organisation is deemed not to bias the responses. A detailed summary of the respondents is shown in the table below.

Table 4.1 Interview respondents

Category	Count	Positions	Organisations
ERP Experts - Software Vendors	2	Head of Business Consulting, Head of Applications Sales Consulting	SAP, Oracle
ERP Experts - ERP Consultants	3	General Manager: Supply Chain Engineering, Senior Consultant, ERP Consulting Manager	Barloworld Logistics, Commerzone, Deloitte Consulting
Business Users	5	Division Business Systems Director, National Supply and Demand Manager, Regional General Manager, Group Business Systems Manager, IT Director	Nampak, Nestle, Colgate Palmolive

4.3.2 Nature of the data

Benefits data. In deciding on the most applicable statistics to use to analyse the ERP benefits data, the distribution of the data first needs to be established. To do this, the total number of responses to the questions (n = 270) is used and the count per interval scale is plotted, as shown on the graph below:

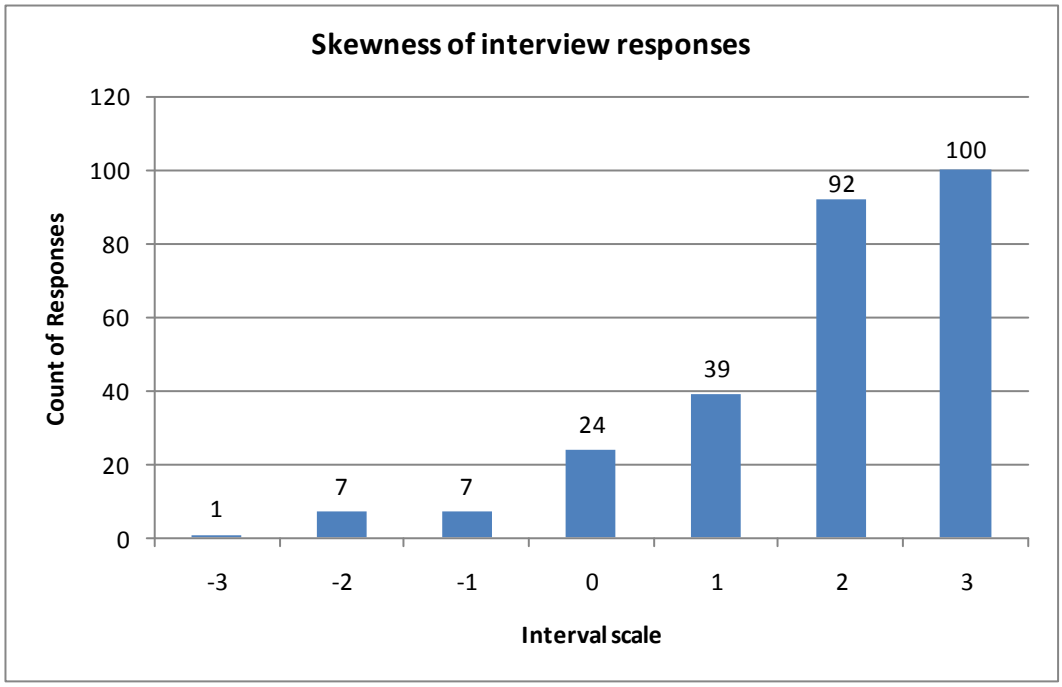


Figure 4.2 Skewness of interview responses

The graph shows an asymmetric tail extending towards the left (with the mass of the distribution concentrated on the right of the figure). This is characteristic of a negatively skewed (or left-skewed) distribution.

The degree of skewness is calculated using Fisher's skewness (equation 4.4) as recommended by Tabachnick and Fidell (1996):

$$G = \frac{n}{(n-1)(n-2)} \sum \frac{(x_i - \bar{x})^3}{\sigma^3}$$

$$G = \frac{270}{(270-1)(270-2)} \sum \frac{(x_i - 1.848)^3}{1.263^3}$$

$$G = -1.3$$

The standard error of skewness for the benefits data is calculated by equation 4.5:

$$ses = \sqrt{\frac{6}{n}} = \sqrt{\frac{6}{270}} = 0.15$$

Since the absolute value for the skewness for the data set (1.3) is greater than twice the *ses* (0.3), the skewness can be described as significant. The negative value of the skewness adds confirmation to Figure 4.2 that the data is "negatively" skewed. This skewness could be an indication of the interview respondents wanting to portray a positive attitude towards ERP systems. The causes for this skewness are discussed in more detail when comparing the interview and market research results.

CSF data. The CSF data can be described as ordinal in nature due to the system that was used to collect the data.

4.3.3 Descriptive statistics

The descriptive statistics chosen to analyse the data are discussed below.

Measure of central tendency

Benefits data. Since the ERP benefits data is significantly skewed the median is deemed to be the most appropriate measure of central tendency.

CSF data. In analysing the CSF data, the median is chosen over the mode as the measure of central tendency.

Measure of variability

Benefits data. Leedy and Ormrod (2005, p262) recommend that, because quartiles are associated with the median, any statistical approach employing the median as the measure of central tendency should also consider the interquartile range/quartile deviation as an appropriate measure for variability. In considering this option for the ERP benefits data one needs to consider the composition of the

data. As the majority of the data lies between "0" and "3" it is felt that the interquartile range will be of little value on such a limited scale. Consequently the use of the standard deviation is favoured. However, because the standard deviation is based on the mean and is more appropriate for normally distributed data, the further the median is from the mean the less appropriate this measure becomes in analysing the spread of the data. Therefore in choosing the standard deviation, a measure of skewness is also required.

CSF data. In deciding between the range and the interquartile range, the interquartile range has been chosen. This measure is favoured over the range as it removes any outlying data from the sample set.

Measure of skewness

When analysing the data for each benefit, the sample set consists of ten responses (i.e. $n = 10$). Due to the low sample size the use of Pearson's skewness is favoured over Fisher's skewness. However, as this measure is to be used in conjunction with the median and standard deviation, it is undesirable to take the standard deviation into account twice. Therefore equation 4.3 is modified for this analysis, so that skewness is the absolute difference between the mean and the median:

$$sk = abs(mean - median) \tag{4.6}$$

The higher this value, the less applicable the standard deviation becomes as a measure of variability and the more interpretation of the ERP benefits data is required.

The above discussions lead to the measures in Table 4.2 being chosen to analyse the interview data:

Table 4.2 Structured interview descriptive statistics

Type of Measure	Measure	Definition
ERP Benefits Data		
Central tendency	Median	Median = Midpoint of ascending data (4.7)
Variability	Standard deviation	$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x - \bar{x})^2}$ (4.8) Where σ = standard deviation $\bar{x}$ = sample mean n = number of variables in the sample
Skewness	Modified Pearson's coeff	Sk = abs (mean – median) (4.6)
CSF Data		
Central tendency	Median	Median = Midpoint of ascending data (4.7)
Variability	Interquartile range	Interquartile range = Quartile 3 – Quartile 1 (4.9)

4.3.4 Application of descriptive statistics

The application of the descriptive statistics in Table 4.2 to the ERP benefits and CSF data sets results in Table 4.3 and Table 4.4 respectively:

Table 4.3 Application of descriptive statistics to ERP benefits data

Key:

Extent of Agreement	
3	Completely Agree
2	Mostly Agree
1	Slightly Agree
0	Neutral
-1	Slightly Disagree
-2	Mostly Disagree
-3	Completely Disagree

ERP Benefit	Vendor 1	Vendor 2	Consultant 1	Consultant 2	Consultant 3	Business User 1	Business User 2	Business User 3	Business User 4	Business User 5	Mean	Median	Skewness	Standard Deviation
Financial Benefits														
1) Reduction in operating and admin costs	2	2	3	3	3	3	2	3	0	2	2.30	2.50	0.20	0.95
2) Reduction in stock levels	0	3	3	2	1	3	3	3	-2	0	1.60	2.50	0.90	1.78
3) Increased turnover	2	0	2	2	1	3	2	3	-2	0	1.30	2.00	0.70	1.57
4) Reduced IT operating costs	3	1	2	-1	-2	1	1	3	2	3	1.30	1.50	0.20	1.70
5) Reduced quality costs	0	2	1	1	1	2	2	-3	2	0	0.80	1.00	0.20	1.55
Internal Business Benefits														
1) Enhanced productivity and efficiencies	2	2	3	3	1	3	3	3	0	2	2.20	2.50	0.30	1.03
2) Improved resource utilization	2	3	3	2	1	2	2	3	-2	3	1.90	2.00	0.10	1.52
3) Enhanced business processes	3	2	2	3	2	3	2	3	2	3	2.50	2.50	0.00	0.53
4) Reduced manufacturing cycle times	1	2	2	2	1	3	2	1	0	0	1.40	1.50	0.10	0.97
5) Reduced data processing time	2	3	3	0	2	2	1	0	2	0	1.50	2.00	0.50	1.18
6) Increased inventory turns	1	2	3	2	1	3	2	3	-2	1	1.60	2.00	0.40	1.51
7) Improved accuracy and timeliness of information	3	3	3	1	-1	1	3	3	3	3	2.20	3.00	0.80	1.40
8) Enhanced internal information sharing	3	3	3	3	2	3	3	3	2	3	2.80	3.00	0.20	0.42
9) Reduced manufacturing lead times	2	2	3	2	1	3	2	3	-1	0	1.70	2.00	0.30	1.34
10) Increased integration of applications	3	3	3	3	2	3	3	3	3	3	2.90	3.00	0.10	0.32
11) Improved decision making	2	2	3	3	-1	2	2	3	1	1	1.80	2.00	0.20	1.23
12) Improved vendor performance	2	2	2	2	1	2	2	1	2	3	1.90	2.00	0.10	0.57
Customer Benefits														
1) Improved customer service	2	3	3	2	1	3	2	3	0	0	1.90	2.00	0.10	1.20
2) Increased on time shipments	2	3	3	3	1	3	2	3	2	0	2.20	2.50	0.30	1.03
3) Improved quality	1	2	2	1	1	2	2	0	2	0	1.30	1.50	0.20	0.82
4) Improved external information sharing	2	1	3	2	-1	3	2	3	0	3	1.80	2.00	0.20	1.40
5) Reduced service lead times	2	2	3	2	1	3	2	2	0	0	1.70	2.00	0.30	1.06
Learning and Growth Benefits														
1) Increased user friendliness of IS	2	1	2	0	0	2	2	-2	-1	3	0.90	1.50	0.60	1.60
2) Changed work patterns	3	1	3	3	3	3	3	3	2	3	2.70	3.00	0.30	0.67
3) Facilitates organisational learning	1	1	2	-1	2	2	3	3	2	2	1.70	2.00	0.30	1.16
4) Empower employees to be more effective	3	2	3	3	2	2	2	1	-2	1	1.70	2.00	0.30	1.49
5) Help build a common vision	3	2	3	1	1	3	2	3	2	3	2.30	2.50	0.20	0.82

Table 4.4 Application of descriptive statistics to CSF data

Key:

Rank	Criticality
1	Most critical
14	Least critical

Rank	Critical Success Factor	Vendor 1	Vendor 2	Consultant 1	Consultant 2	Consultant 3	Business User 1	Business User 2	Business User 3	Business User 4	Business User 5	Median	Interquartile Range
1	Top management commitment	2	1	3	1	1	1	1	1	1	2	1.0	0.75
2	Business plan, vision & strategy	1	10	7	2	2	4	2	2	8	1	2.0	4.25
3	Change management	9	2	1	4	4	6	3	3	2	3	3.0	1.75
4	Education and training	6	5	4	5	9	5	5	7	4	8	5.0	1.75
5	Business process re-engineering	4	8	5	3	3	8	4	6	9	13	5.5	4.00
6	ERP team composition	7	7	8	8	7	7	13	4	10	4	7.0	1.00
7	Project management	12	4	11	6	5	10	8	5	5	9	7.0	4.75
8	Effective communication	10	3	2	7	8	9	6	11	3	7	7.0	5.00
9	Minimum customisation	5	6	14	10	14	2	11	12	6	11	10.5	5.75
10	Software development, testing &	11	12	6	11	11	11	12	8	7	11	11.0	2.25
11	ERP package selection	8	13	13	12	10	3	14	9	14	5	11.0	4.75
12	Performance evaluation	13	9	12	9	6	12	10	14	11	14	11.5	3.50
13	IT infrastructure	14	11	9	13	12	13	9	10	13	6	11.5	3.75
14	Appropriate business & legacy systems management	3	14	10	14	13	14	7	13	12	12	12.5	3.25

4.4 Discussion of the Interview Results

4.4.1 ERP benefits data analysis and interpretation

The ABC classification process described in Appendix C: ABC Classification has been applied to the results to produce Table 4.5:

Table 4.5 ABC analysis of benefits

Key:

Extent of Agreement	
3	Completely Agree
2	Mostly Agree
1	Slightly Agree
0	Neutral
-1	Slightly Disagree
-2	Mostly Disagree
-3	Completely Disagree

ERP Benefit	Descriptive Statistics			Interview "ABC" Classification					Overall Classification		
	Median	Skewness	Standard Deviation	Median "ABC"	Skewness "ABC"	Std Dev "ABC"	Combined Interview Classification	Final Interview Classification	Literature Review Classification	Literature & Interview Classification	Overall "ABC" Classification
Financial Benefits											
1) Reduction in operating and admin costs	2.50	0.20	0.95	A	A	A	AAA	A	A	AA	**A**
2) Reduction in stock levels	2.50	0.90	1.78	A	C	C	ACC	B	B	BB	**B**
3) Increased turnover	2.00	0.70	1.57	B	C	C	BCC	C	B	BC	**B**
4) Reduced IT operating costs	1.50	0.20	1.70	B	A	C	BAC	B	B	BB	**B**
5) Reduced quality costs	1.00	0.20	1.55	C	A	C	CAC	C	C	CC	**C**
Internal Business Benefits											
1) Enhanced productivity and efficiencies	2.50	0.30	1.03	A	B	B	ABB	A	B	BA	**A**
2) Improved resource utilization	2.00	0.10	1.52	B	A	C	BAC	B	C	CB	**B**
3) Enhanced business processes	2.50	0.00	0.53	A	A	A	AAA	A	A	AA	**A**
4) Reduced manufacturing cycle times	1.50	0.10	0.97	B	A	A	BAA	B	B	BB	**B**
5) Reduced data processing time	2.00	0.50	1.18	B	B	B	BBB	B	B	BB	**B**
6) Increased inventory turns	2.00	0.40	1.51	B	B	C	BBC	B	C	CB	**B**
7) Improved accuracy and timeliness of information	3.00	0.80	1.40	A	C	B	ACB	B	A	AB	**A**
8) Enhanced internal information sharing	3.00	0.20	0.42	A	A	A	AAA	A	A	AA	**A**
9) Reduced manufacturing lead times	2.00	0.30	1.34	B	B	B	BBB	B	C	CB	**B**
10) Increased integration of applications	3.00	0.10	0.32	A	A	A	AAA	A	A	AA	**A**
11) Improved decision making	2.00	0.20	1.23	B	A	B	BAB	B	A	AB	**B**
12) Improved vendor performance	2.00	0.10	0.57	B	A	A	BAA	B	C	CB	**B**
Customer Benefits											
1) Improved customer service	2.00	0.10	1.20	B	A	B	BAB	B	B	BB	**B**
2) Increased on time shipments	2.50	0.30	1.03	A	B	B	ABB	A	B	BA	**A**
3) Improved quality	1.50	0.20	0.82	B	A	A	BAA	B	C	CB	**B**
4) Improved external information sharing	2.00	0.20	1.40	B	A	B	BAB	B	A	AB	**A**
5) Reduced service lead times	2.00	0.30	1.06	B	B	B	BBB	B	C	CB	**B**
Learning and Growth Benefits											
1) Increased user friendliness of IS	1.50	0.60	1.60	B	C	C	BCC	C	C	CC	**C**
2) Changed work patterns	3.00	0.30	0.67	A	B	A	ABA	A	C	CA	**A**
3) Facilitates organisational learning	2.00	0.30	1.16	B	B	B	BBB	B	C	CB	**B**
4) Empower employees to be more effective	2.00	0.30	1.49	B	B	B	BBB	B	C	CB	**B**
5) Help build a common vision	2.50	0.20	0.82	A	A	A	AAA	A	C	CA	**A**

The following decisions result from the application of the ABC classification rules:

1. 11 "A" benefits are included in the market research.
2. 14 "B" benefits are analysed more closely to determine if they should be included in the market research.
3. Two "C" benefits, namely "reduced quality costs" and "increased user friendliness of IS" are excluded from the list due to lack of support.

The "B" benefits are analysed in detail in the following sections:

Reduction in stock levels

The literature provides moderate support for this benefit. If the interview data is then analysed, a high median adds further support to this benefit. However, as the skewness and standard deviation are high it can be said that there is a discrepancy (high variation) in interviewee responses. In looking at the interviewee comments it can be seen that the general consensus is that although ERP can assist in reducing stock levels, the main benefit will only be realised through the addition of Advanced Planning and Scheduling (APS) applications. Based on the literature support and high median, this benefit is included, although the market research needs to be designed in such a way as to differentiate between companies that have APS systems installed and those that do not. This will help mitigate the risk of attributing stock level benefits resulting from an ERP/APS combination solely to ERP systems.

Increased turnover

Moderate evidence exists in the literature to support this benefit. Overall the data shows that the sample set mostly agree with this benefit being attainable; however there is a high degree of variation in the interviewee responses which is greatly skewed to the negative. Analysing the interviewee comments reveals that this variation may be due to increased turnover being regarded as a secondary or indirect benefit of ERP (i.e. mainly attributed to enabling tools), and is also dependant on how the organisation uses the ERP data and reports to drive its

sales. Overall there is deemed to be sufficient support for this measure to retain it in the market research, although the degree to which enabling tools are in place within the surveyed organisations needs to be established to correctly attribute this benefit.

Reduced IT operating costs

Moderate support exists in the literature for this benefit. Analysis of the interview data shows that the median is between "slightly agree" and "mostly agree". The comments reveal that the high degree of variation is due to the uncertainty around the IT base from which implementing companies are moving, i.e. if the implementing company is operating in a multi-system, highly supported environment IT costs should decrease due to consolidation of systems. However, if the company is coming from a low IT base, investment in infrastructure and additional IT support could drive costs up. Due to the moderate overall support for this benefit it is included in the market research, although the research should aim to establish the IT base from which implementing organisations are moving.

Improved resource utilization

Although little literature support was found for this benefit, the interviews confirmed that this benefit should be expected. The median indicates that overall respondents mostly agree that this benefit should be realised, with only one respondent indicating that this benefit should not be expected - which inflated the standard deviation. The interviewee comments reveal that this ERP benefit should be expected for both human resource and machine resource utilization, but can be taken further with the use of APS applications. Due to the favourable interview support, this benefit has been included in the market research.

Manufacturing cycle times

Although there is moderate support for this benefit, and the interview data median lies between "slightly agree" and "mostly agree" (with little skewness and variability), the comments reveal that this benefit is felt to be dependent on Manufacturing Enterprise Systems (MES) and APS systems (together with factory

floor processes and flexibility) and is not directly impacted by ERP. This together with the explanation that was required in the interviews to differentiate "manufacturing cycle time" from "manufacturing lead time" has led to this measure being excluded from the market research. Instead "manufacturing lead time" is included as discussed below.

Reduced manufacturing lead times

Little support was found in the literature to confirm this benefit. In analysing the interview response the median indicates a value of "mostly agree", although the relatively high skewness and standard deviation shows that there is discrepancy within the responses on the degree to which this benefit should be expected. The comments reveal that although some benefit can be expected the main benefit will manifest as the result of APS applications. As explanation was required in the interviews to clarify the difference between "manufacturing cycle time" and "manufacturing lead time", it has been decided to remove this confusion by including only one of these benefits in the market research. As cycle times are more influenced by MES systems and shop floor processes (not directly covered in this research), and the comments indicate that lead times are influenced more by ERP, the "reduced manufacturing lead times" benefit is favoured for inclusion. Despite the high variance and lack of literature support it is felt that the median value together with the interviewee comments is sufficient to justify inclusion of this measure in the market research.

Reduced data processing time

The literature shows moderate support for this benefit which is backed up by the interview data median tending towards "mostly agree". Although some variability exists in the interview data, no respondents indicated that this benefit is not achievable. The comments indicate that whereas the single point of entry (due to integrated nature of ERP systems) should help reduce overall data entry time, the amount of data to be entered may increase compared to the legacy systems from which the organisation is moving. Overall the feedback is that data processing

time should be expected to decrease and therefore this benefit is included in the market research.

Increased inventory turns

The literature support for this benefit is weak, however the interview data median of "mostly agree" combined with the low variability (0.87) that is obtained if the one response of "mostly disagree" is removed from the data set, show that overall the interviewee respondents feel that this benefit is achievable. To achieve this benefit however, the interviewee comments explain that the specific focus needs to be placed on applying the ERP philosophy and using the ERP reporting capabilities. Due to the interviewee confidence in this benefit it is included in the market research.

Improved vendor performance

Despite a low level of literature support for this benefit, the interview data shows a median value of two (mostly agree) with a low degree of variability. The interview comments attribute this benefit to greater information availability, together with enhanced procedures resulting from ERP, which should enable suppliers to be managed more effectively. The consensus on the interview data is deemed sufficient to validate the inclusion of this benefit in the market research.

Improved customer service

There exists moderate literature support for this benefit. The interview data supports the literature with a median of "mostly agree" and no respondents disagreeing with the existence of this benefit. The comments obtained indicate that this is an indirect benefit of ERP, i.e. ERP increases and enhances the availability of information, but it is dependent on the users to analyse the information effectively to ensure a higher level of customer collaboration and service. Due to the moderate literature support and no evidence in the interviews contradicting its existence, this benefit is included in the market research.

Improved quality

Literature support for this measure is low, and the interview data shows a high level of consensus (lack of variability) around a median of 1.5. Although interview data shows that this benefit may exist, the comments reveal that this is not seen as a direct benefit: product quality is more affected by production processes and making quality a specific goal within an organisation than it is from ERP. The interview feedback is deemed insufficient to make up for a lack of literature support, and consequently this benefit has been removed from the market research.

Reduced service lead times

Although low literature support was found for this benefit, the interview data show a median of "mostly agree" with moderate levels of variability and no respondents disagreeing with the existence of this benefit. However, the comments show that the respondents are divided on whether this benefit is the result of ERP (due to increased information utilisation and following ERP philosophy) or APS tools. As there is a high level of interviewee agreement on the existence of this benefit it is included in the market research.

Facilitates organisational learning

There is little literature support for this benefit, although barring one response all interviewees support the existence of this benefit. ERP is seen by the interview respondents as a means to standardise education and business courses throughout an organisation and is therefore included in the market research.

Empower employees to be more effective

Although there is a low level of literature support for this benefit, with the exception of one response, all interview responses support this benefit. The comments attribute this benefit to the increased availability of information and stricter process control that equip users to make better decisions. The interview response is deemed sufficient to validate the inclusion of this benefit in the market research.

Additional benefits

The general comment by the interviewees was that the majority of main benefits have been included. An evaluation of the suggested additional benefits is provided in Appendix E: Consolidated Interview Responses. Of the benefits suggested, most are deemed to be secondary benefits which can be linked to benefits in the initial list and are therefore excluded from further consideration. The three benefits which warrant further consideration for inclusion are:

1. better control of authorisation;
2. enhanced performance management through common KPIs; and
3. improved share price.

It is decided not to include "better control of authorisation" as this depends largely on ERP setup, together with the access given to certain users. The same benefit can be achieved through the correct setup of certain legacy systems. "Performance evaluation" is tested under the CSF section of the interviews and is evaluated in section 4.4.2 to be one of the less significant CSFs. By association and due to the lack of additional support, the benefit of "performance management through common KPIs" is deemed to be of lesser importance. It can also be argued that establishing a common set of KPIs is a business decision and can be controlled without using an ERP system, provided sufficient data is available from alternate systems. "Improved share price" is not included as it is deemed to be influenced by too many external factors. Further, unless the share price fluctuation is noted at the same time as the press announcement of the ERP implementation, it is highly improbable that a convincing association can be made.

Possible source of bias

In the discussions around the relevance of the benefits the comment was frequently noted that certain benefits could be taken further with the addition of APS or similar enabling systems. This may lead to bias in the results when conducting the market research if respondents mistakenly attribute benefits, due at least in part to APS/enabling systems, to the ERP system.

4.4.2 CSF data analysis and interpretation

Table 4.6 CSF analysis

Key:

Rank	Criticality
1	Most critical
14	Least critical

Rank	Critical Success Factor	Median	Interquartile Range	Literature Review	Category
1	Top management commitment	1.0	0.75	A	1
2	Business plan, vision & strategy	2.0	4.25	A	1
3	Change management	3.0	1.75	A	2
4	Education and training	5.0	1.75	B	2
5	Business process re-engineering	5.5	4.00	B	2
6	ERP team composition	7.0	1.00	B	2
7	Project management	7.0	4.75	A	2
8	Effective communication	7.0	5.00	B	2
9	Minimum customisation	10.5	5.75	B	3
10	Software development, testing &	11.0	2.25	C	3
11	ERP package selection	11.0	4.75	B	3
12	Performance evaluation	11.5	3.50	B	2
13	IT infrastructure	11.5	3.75	C	3
14	Appropriate business & legacy systems management	12.5	3.25	C	3

Ranking the CSFs according to their central tendency results in the ordered table shown above. Section 2.3 noted that it is desirable to limit the list to ten CSFs to enable the market research to be as concise and focused as possible (minimising respondent fatigue). Adhering to this requirement would see items 11 to 14 being dropped from the above list. However, before this is done, the interview comments together with the additional CSFs need to be considered:

Reviewing the interview comments reveals that at least three of the interviewees feel that the CSFs can be grouped into categories of importance. Consolidating their comments provides us with the three categories shown in Table 4.7:

Table 4.7 CSF categories

Category	Level of Importance
1) Leadership, vision and strategy	Most important
2) People and processes	2nd most important
3) Technology	Least important

Applying these categories to Table 4.6 reveals that three of the four measures in question fall within the "technology" category (least important). The remaining measure falls under the "people and process" category, but can be seen as an extension of project management which is included further up the list. All of these measures received medium to low literature support.

In analysing the level of variation to determine if there is justification in moving any of the four lowest ranked CSFs up the list it can be seen that four of the top ten ranked CSFs have an interquartile range of 4 or greater (indicating a relatively high degree of variability in responses). However, in analysing the lowest four CSFs, a similar level of variability is observed (with most interquartile ranges approaching 4). This lack of consensus in both areas provides no conclusive justification for changing the order of the CSFs on the list.

Taking the above arguments into consideration, it is decided that removing the bottom four CSFs from the list will not adversely affect the outcome of the research. This decision produces the focused and concise list that was the aim of this phase of the research.

The additional CSFs provided by the interviewees (shown in Appendix E: Consolidated Interview Responses) can be grouped into one of the remaining CSFs on the list, i.e. "business plan, vision and strategy", "change management", or "education and training". Based on this analysis none of the additional measures are added to the list of CSFs. Therefore the final list of CSFs, that is used in the market research, is numbers one to ten in Table 4.6.

4.5 Summary of Structured Interviews Results and Findings

This chapter of the research set out to validate the lists of ERP benefits and CSFs identified through the literature review. To achieve this aim, a structured interview approach was adopted. In total ten interviews were conducted with local ERP system experts and business users. The analysis of the interview results together with the literature data enabled a consolidated list of ERP benefits to be drawn up. Insufficient support was obtained for four of the benefits identified through the literature, namely:

1. reduced quality costs;
2. reduced manufacturing cycle times;
3. improved quality; and
4. increased user friendliness of IT.

These benefits have been left out of the market research. No additional benefits were added to the list obtained via the literature review. The consolidated list of ERP benefits, deemed to be relevant to the SA manufacturing sector, is shown in Table 4.8. The extent to which companies are achieving these benefits is determined via the market research, enabling Sub-Problem I to be fully investigated:

Part 1: What are the benefits that manufacturing companies are gaining as the result of implementing ERP systems?

Part 2: To what extent are benefits being achieved over the three year post "go-live" period?

By using the validated list of ERP benefits (Table 4.8), to populate the ERP Time-Based BSC it can be said that that the content validity of the measurement instrument has been confirmed, thus supporting the first portion of Sub-Problem II:

Is the ERP Time-Based BSC a valid and reliable ERP PMS?

The CSFs obtained from the literature review were assessed, and the list refined by asking the interviewees to rank the CSFs according to order of importance. This method led to the following four CSFs being removed from the list:

1. ERP package selection;
2. performance evaluation;
3. IT infrastructure; and
4. appropriate business and legacy system management.

After consideration, none of the additional CSFs suggested by the interviewees were added to the CSF list. The resulting list of ten CSFs validated the findings of the literature review and confirmed its applicability to the SA market. This list of ten CSFs (Table 4.8) is used in the market research to further investigate Sub-Problem IV:

What CSFs can be associated with ERP benefits being achieved?

Table 4.8: ERP benefits and CSFs for further investigation

ERP Benefits	Critical Success Factor
Financial Benefits	1) Top management commitment
1) Reduction in operating and admin costs	2) Business plan, vision & strategy
2) Reduction in stock levels	3) Change management
3) Increased turnover	4) Education and training
4) Reduced IT operating costs	5) Business process re-engineering
Internal Business Benefits	6) ERP team composition
1) Enhanced productivity and efficiencies	7) Project management
2) Improved resource utilization	8) Effective communication
3) Enhanced business processes	9) Minimum customisation
5) Reduced data processing time	10) Software development, testing & troubleshooting
6) Increased inventory turns	
7) Improved accuracy and timeliness of information	
8) Enhanced internal information sharing	
9) Reduced manufacturing lead times	
10) Increased integration of applications	
11) Improved decision making	
12) Improved vendor performance	
Customer Benefits	
1) Improved customer service	
2) Increased on time shipments	
4) Improved external information sharing	
5) Reduced service lead times	
Learning and Growth Benefits	
1) Changed work patterns	
2) Facilitates organisational learning	
3) Empower employees to be more effective	
4) Help build a common vision	

5 METHODOLOGY & RESULTS: MARKET RESEARCH

This chapter of the research utilizes the ERP benefits and CSF lists, defined through the preceding two chapters, together with the ERP Time-Based BSC to investigate further the four objectives and related hypotheses.

To test the four hypotheses sufficient market related data is required. As most of this data resides within the knowledge of senior level business personnel, an effective method of obtaining this data is deemed to be through a survey approach. The survey takes the form of a questionnaire that was emailed to the targeted sample set to determine the level to which ERP benefits have been achieved, and extent to which CSFs were in place during the implementations.

Before data are analysed the influencing factors and possible sources of bias are considered. The survey results are then summarised and described in line with the research steps highlighted in section 3.4. The chapter concludes by summarising the results and laying the foundation for the discussion in Chapter 6.

5.1 Objectives of the Market Research

The central purpose of the market research is to gather sufficient field data to test the four hypotheses proposed in the methodology section of the research. The research attempts to achieve this by focusing on the following objectives:

1. Determine the extent to which ERP benefits have been achieved by surveyed companies who have implemented ERP systems.
2. Determine the reliability of the ERP Time-Based BSC.
3. Build the ERP benefits results into the ERP Time-Based BSC to determine the impact on organisational performance.
4. Establish the extent to which CSFs have been in place during the surveyed ERP implementations.
5. Analyse the results to determine if a link can be found between the CSFs and ERP.

6. Gather sufficient background information surrounding the ERP implementations to avoid concluding that a result is not due to chance when in fact it is due to chance (Type I error), or that a result is due to chance when in fact it is not (Type II error).

5.2 Market Research Methodology

The market research was conducted in line with the research methodology described in Chapter 3. This approach is highlighted in Figure 5.1.

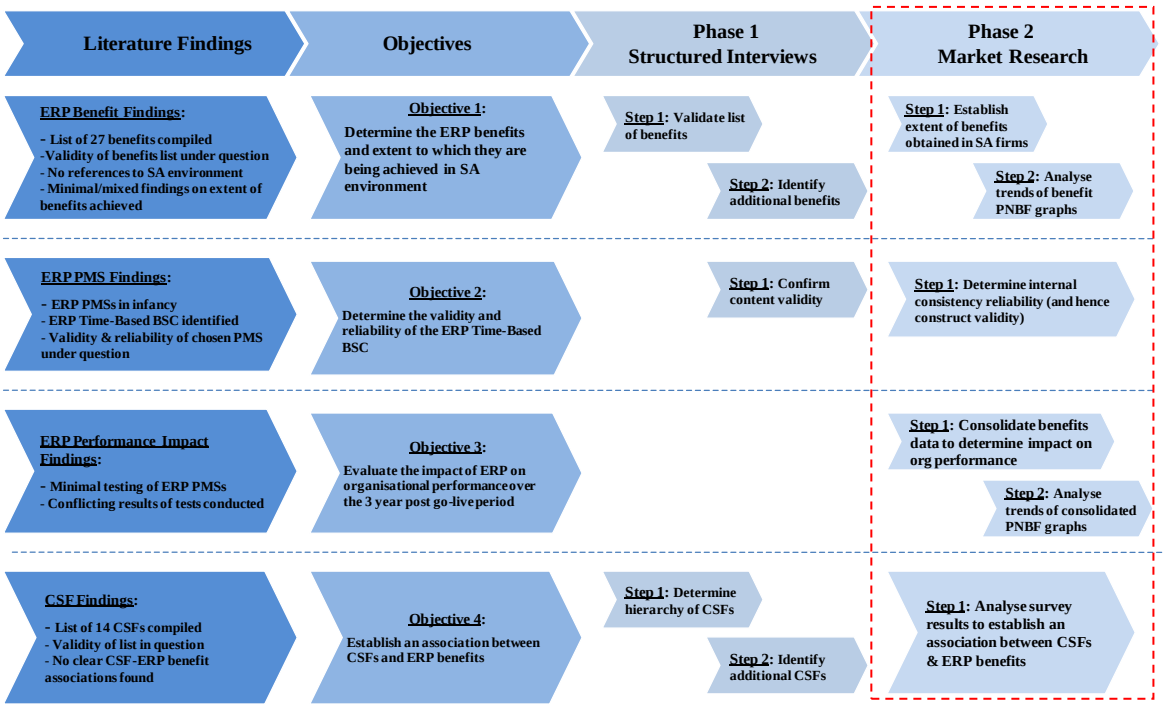


Figure 5.1 Research methodology – market research

The data collection and assessment methodologies for the market research are discussed in detail in sections 5.2.1 and 5.2.2:

5.2.1 Data collection methodology

Data needed

The data needed consists of feedback from organisations who have implemented ERP systems regarding:

1. The extent to which ERP benefits have been achieved over the post "go-live" periods (i.e. "year 1", "year 2", and "year 3").
2. The extent to which the identified CSFs were in place during the implementation cycle.
3. Background company information (for example, the organisation size, processes and IT/enabling systems in place) to assist with accurately analysing the results.

Data location

The required data resides with the organisations who have implemented ERP systems. However, the likelihood is that this information has either not been formally documented by the implementing organisations, or is scattered across multiple data records over the post implementation period. Therefore, a better source of providing the needed data would be the organisations' senior managers and executives who were involved in the implementation and post-implementation periods and understand the overall functionality of the ERP system and the impact it has had on their organisations. Senior managers/executives with the most ERP knowledge and interest are targeted for the survey. This not only ensures that the data received is accurate, but as subject interest has been found in increase response rates (Sheehan & McMillan, 1999) this approach is also expected to encourage a higher participation level.

Instrumentation

As pointed out in the objectives section, the central objective of this section of the research is to gather sufficient data to test the four hypotheses. This involves securing feedback from a sufficient number of organisations to validate the results and limit possible sources of bias. The following approaches are considered to secure the data:

1. Face-to-face interviews: this method proved successful in establishing the set of expected benefits and CSFs. By meeting face to face with the participants for this phase of the research, the researcher would be able to clarify any questions the participants might have, as well as ensure that a response is received once the meeting has been set up. However, the major drawbacks to this approach are the number of interviews that would have to be set up (up to 79) as well as the location of the participants (spread across SA). This approach is therefore deemed not to be feasible.
2. A modification of the face-to-face interviews would be to arrange telephone interviews. However, because of the calibre of participants (senior executive/managers) being targeted, it is felt that these individuals will not be able to spare the time required for a full interview.
3. The third option considered, takes the form of a questionnaire to be sent to the participants. This method has the following advantages:
    a. The total sample set (of 79 companies) can be contacted over a fairly short duration.
    b. The time taken by the participant to complete a questionnaire would be considerably less than the time spent in an interview (provided sufficient thought has been put into the design of the questionnaire).
    c. As questionnaires can be completed simultaneously and follow up procedures can be initiated in parallel with the targeted companies, the duration of the data gathering period can be minimised.

    However, one of the major drawbacks anticipated with this approach is that should the respondent misinterpret the questions, the results could be misleading. However, this problem can be mitigated by conducting a pilot study (as recommended by Leedy and Ormrod, 2005, p192), as well as by establishing a personal contact with the participant prior to sending through the questionnaire, offering personal guidance should it be required.

Taking the above into consideration, the instrument that is deemed to best suit this phase of the research is the use of a questionnaire to be sent to the identified contact people in the targeted companies.

On deciding on the format and distribution method for the questionnaire, the factors that are given the highest priority are the quality of the data required as well as the response rate. To ensure that the data gathered is clear and accurate, avoiding risk of ambiguity and misinterpretation, it is decided that the questionnaire should be quantitative in nature. The distribution methods considered include: mailing the questionnaire via the SA postal service; emailing the questionnaire; or posting the questionnaire on the web and emailing the internet site details to the targeted participants. Research on the response rates between mail surveys and email surveys provides conflicting results with debate over which method yields the highest response rates (e.g. Bachman et al, 1999; Opperman, 1995; Schaefer & Dillman, 1998). However, when it comes to response speed and cost effectiveness, Sheehan and McMillan (1999) have demonstrated email surveys to be far superior. As it is also easier to monitor and manage aspects such as questionnaire receipt details, follow up reminders, and gathering of responses, email is favoured over conventional mail. On deciding between using an emailed questionnaire verses a web-based questionnaire the advantages and disadvantages are less clear: with both requiring the user to be computer literate (which is expected of all participants in the sample set) and both having similar benefits over conventional mailing methods. However, as the email contacts obtained for the sample set would have to be used to provide the participant with the overview information as well as the web address for the web survey (if this approach is chosen), it would simplify the approach to attach the questionnaire to the initial email.

Therefore, taking the above into consideration, the instrument that is chosen to gather the data is a quantitative questionnaire to be emailed to the targeted participants. Since the ultimate goal of this approach is to learn about a large

population by surveying a sample of that population, this approach can be described as a descriptive survey approach (Leedy and Ormrod, 2005, p183).

Note: the term "survey", with reference to this market research, refers to the sampling of the 79 companies in the sample set.

The **questionnaire design** is compiled based on two main objectives:

1. Firstly, to produce a format to enable a concise and complete set of data to be collected, that can be analysed via statistical methods.
2. Secondly, to produce a format aimed at encouraging a high response rate.

To address the first objective, a draft questionnaire is designed based on the feedback received from the structured interviews. The content deemed essential to the questionnaire design includes: participant information, sources of bias, CSFs in place and benefits achieved. The second objective is addressed by investigating the methods used by previous research to encourage a high response rate. The findings are built into the draft questionnaire design and the covering and reminder letters.

The **pilot study** sets out to test the questionnaire at the various respondent levels (i.e. group, division and plant level). To this end three participants are selected for the pilot study: a group Chief Information Officer (CIO); a divisional Supply Chain Director; and a plant General Manager. The feedback received leads to design changes in two main areas:

1. Firstly, the format of the questionnaire is adjusted to include the feedback data all on one worksheet.
2. Secondly, the explanations and definitions provided are updated to facilitate the participants' understanding of the questions.

The result is a tested questionnaire (and covering letter) format, which is used to conduct the survey.

(A detailed description of the **questionnaire design** and **pilot study** is provided in Appendix F: Market Research Questionnaire Design).

Securing the data

The following approach was adopted to secure the data:

1. Contacted the potential participants through a personal telephone call, where possible, to establish a personal rapport and ask for their participation in the survey. Sheehan (2001) recommends that this pre-notification is not only good research practice and etiquette, but could also lead to a higher response rate.
2. Sent personalised emails, with the covering letter embedded in the email and the questionnaire attached, to the participant asking for his/her response by a given date (set as two weeks after the initial email). By personalising the emails it was hoped that an increased response rate would be received (Jensen, 2009). The covering letter was used to provide the participant with a description of the study and instructions for the questionnaire completion, as well as increase response rates (see Appendix F: Market Research Questionnaire Design for details). By setting the return deadline as two weeks the participant could prioritise the questionnaire, and a base for follow up reminders could be established.
3. If the questionnaire (or response to the email) was not received within one week a follow up email was sent to the participant reminding him/her of the closing date. Follow up emails were used as this technique has been found to have a positive influence on response rates (Sheehan, 2001). A reminder lead time of one week (seven days) was adopted as Sheehan and McMillan (1999) found this to be the average response length for studies involving emailed questionnaires.
4. A further email, and or telephone call, was sent the day after the closing date to determine if the contact was still willing to participate, and provide a few days extension if required. The number of reminders was capped at two as recommended by previous research (Shih & Fan, 2009, p33).
5. If positive feedback was not received after point 4, the participant was classified as a non-respondent.
6. A log of questionnaires mailed, reminder emails, and responses received was kept to track and administer the participant feedback.

5.2.2 Data assessment methodology

Once the nature of the data has been determined, the data is analysed in line with the objectives using a combination of descriptive and inferential statistics to address the sub-problems and evaluate the hypotheses:

Determine the nature of the data

As discussed in Appendix F: Market Research Questionnaire Design, the questionnaire makes use of two key tables to collect information for the ERP benefits achieved and CSFs in place. Both tables are populated by using the Likert scales detailed in the questionnaire. In both cases the scales have been designed to reflect equal (and discrete) units of measure to correspond to the degree of ERP benefits being achieved, and extent to which CSFs were in place. The data can therefore be described as being interval in nature.

In determining the distribution of the data, each benefit and CSF is treated on an individual basis.

Data assessment methodology for objective 1

Objective 1 is addressed by assessing the data related to **Sub-Problem I**:

Part 1: What are the benefits that manufacturing companies are gaining as a result of implementing ERP systems?

Part 2: To what extent are benefits being achieved over the three year post "go-live" period?

As specified in section 3.4.1 this is done in two steps:

Step 1: Establish the level to which benefits have been obtained by selected SA manufacturing firms, over the three year post "go-live" period

Firstly, by analysing the results and calculating the average benefits using a measure of central tendency, the level to which benefits are being achieved is established. Secondly, to determine if these results differ significantly from zero relevant confidence intervals are calculated.

Measure of central tendency. Since the data are collected on interval scales, the mean, mode and median are considered. The choice of measure depends on the distribution of the data, with the mean being favoured for normally distributed data and the median being favoured if the data are skewed.

As the distribution of the underlying data cannot be accurately determined given the sample response size (see section 5.3.1), averages (means) are mainly used. Lapin (1973) explains that as the sample size of the averages increases the distribution of the averages tends towards the normal (Gaussian) distribution. However, the Student's t-distribution is more applicable with small sample sizes. This determines the methods used to establish the significance levels about the mean.

Statistical significance. Calculating the mean on its own would be insufficient as it gives a point estimate, but provides no information regarding our confidence in the results. To avoid making errors in hypothesis testing, Leedy and Ormrod (2005, p270) state it is common place to use a 95% confidence interval to ensure statistical significance.

Lapin (1973, p277) specify that for a small sample size (in our case 17 observations) the Student's t-distribution is the most appropriate distribution for calculating the confidence intervals. The confidence intervals are calculated using the formula as described by Lapin (1973):

$$\bar{x} - t_{\propto}\frac{s}{\sqrt{n}} \ll \mu \ll \bar{x} + t_{\propto}\frac{s}{\sqrt{n}} \qquad (5.1)$$

Where:
$\bar{x}$ = sample mean
s = sample standard deviation
n = number of observations
μ = zero (to test if benefits differ significantly from zero)

$\alpha = (1-C)/2$, where C is the confidence interval. Therefore, for a 95% confidence interval $\alpha = 0.025$

$t_{0.025}$ is determined by calculating the degrees of freedom as *n*-1 and looking up the respective value for a two sided distribution on the Student's t-distribution table (shown in Appendix G: Sample Calculations).

Step 2: Build the average ERP benefit results into PNBF graphs to determine if benefits can be expected to increase over time

Having determined the benefits that are being achieved through step 1, this step combines the year-by-year results into consolidated PNBF graphs (progress curves). By analysing the trends of the graphs the results are assessed to determine if benefits can be expected to increase over the three year period (and to what extend).

Data assessment methodology for objective 2

Objective 2 is addressed by assessing the data related to **Sub-Problem II**:
Is the ERP Time-Based BSC a valid and reliable ERP PMS?

Having confirmed the content validity of the ERP Time-based BSC through the structured interviews, this assessment aims to establish the reliability of the ERP Time-based BSC. As described in Chapter 3, Cronbach's α has been selected to measure the internal consistency reliability of the ERP Time-Based BSC using the survey results.

For this assessment, the four perspectives (Financial Perspective, Internal Business Perspective, Customer Perspective, and Learning & Growth Perspective) form the latent variables, with the benefits within each category comprising the items to be tested. These latent variables are then collectively analysed to test Organisational Performance as the final latent variable. Figure 5.2 shows how the benefits relate to the latent variables.

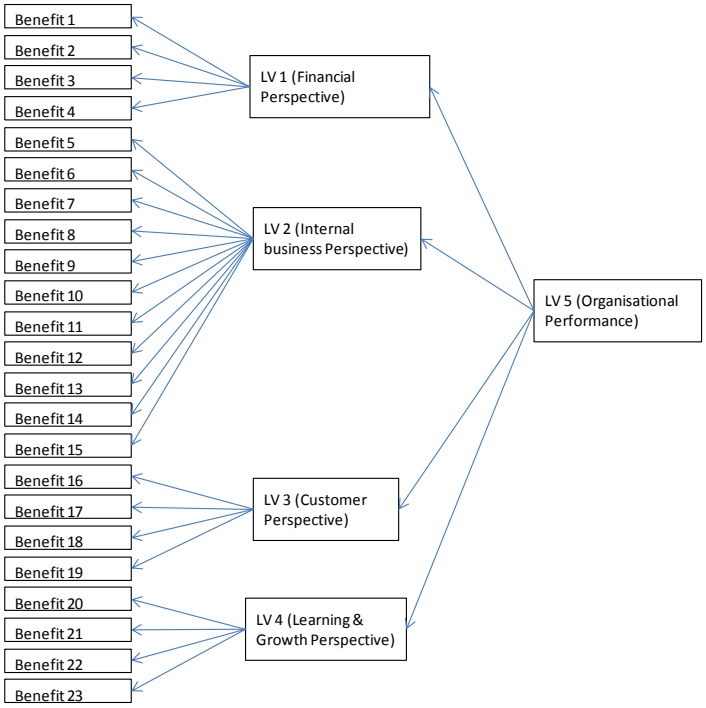


Figure 5.2 Latent variables to be tested using Cronbach's α

Due to the high number of variables involved in calculating Cronbach's α for this study, a statistical software package PASW - Predictive Analytics Software (an updated version of SPSS) has been used to process the data.

As stated in section 3.6, the closer Cronbach's α is to 1 the greater the internal consistency of the items in the scale. George and Mallery (2003) recommend the following guide for evaluating Cronbach's α:
>0.9 – Excellent, >0.8 - Good, >0.7 – Acceptable, >0.6 – Questionable, >0.5 – Poor and <0.5 – unacceptable.
This guide is used in this study to analyse the results.

Data assessment methodology for objective 3

Objective 3 is addressed by assessing the data related to **Sub-Problem III**:
How are ERP benefits impacting on the organisational performance of the company over the three year post "go-live" period?

As with Sub-Problem 1, the data are assessed in two steps:

Step 1: Consolidate the ERP benefits results into the four quadrants of the ERP Time-Based BSC to determine if the consolidated results differ significantly from zero over the three year post "go-live" period

Following the same logic as described for assessing objective 1, the mean is used as the measure of central tendency to determine if the consolidated results differ from zero. A 95% confidence interval, using the Student's t-distribution is calculated to test if the results are significant.

Step 2: Construct PNBF graphs to display the consolidated effect of the ERP benefit results over the three year time period, and hence gauge the impact on organisational performance

Having determined the performance impact for each of the three years, this step combines the year-by-year results into consolidated PNBF graphs. By analysing the trends of the graphs the results are assessed to determine if organisational performance can be expected to increase over the three year period (and to what extent).

Data assessment methodology for objective 4

Objective 4 is addressed by assessing the data related to **Sub-Problem IV**:
What CSFs can be associated with ERP benefits being achieved?

The data is assessed from two perspectives: firstly, descriptive statistics are used to establish the level to which CSFs were in place, and secondly an attempt is made to associate the CSFs with the benefits achieved.

Step 1: Establish the extent to which CSFs have been in place during the surveyed ERP implementations

To establish the level to which CSFs have been in place a measure of central tendency as well as variably is required.

Measure of central tendency. Since the data was collected on interval scales, the mean, mode and median are considered (Leedy and Ormrod (2005), p260). As described previously, the true distribution of the data is unable to be ascertained due to the low sample size. Consequently, the mean is chosen as the measure of central tendency and the Student's t-distribution is assumed for the averages.

Measure of variability. Since the mean has been selected as the most appropriate measure of central tendency, the standard deviation (as recommended by Leedy and Ormrod (2005), p263) is chosen as the measure of variability. However, as a spread of values is required to establish a meaningful association, the range is also calculated.

Step 2: Test for an association between CSFs being in place and benefits being achieved

To test this association parametric tests and non-parametric tests where considered. Based on the recommendations of Lapin (1973) the Chi-Squared test was evaluated to be the most favourable test. However, due to less than 20

responses being received for the survey the frequency expected per quadrant within the Chi-Squared test would be less than five. Lapin (1973, p396) stipulates that such a result would invalidate the test. As an alternative, linear regression is chosen to determine an association between CSFs and benefits achieved.

Making "benefits" the Dependent Variable (DV) and "CSF" the Independent Variable (IV), the regression equation is shown as:

$$\text{Benefits} = B_0 + B_1\text{CSF} + \text{error} \tag{5.2}$$

Three aspects of the linear regression results are analysed:

1. The sign and strength of the association is determined by the gradient of the regression line.
2. A linear regression t-test is conducted to determine if the slope of the regression line differs significantly from zero.
3. The fit of the regression line is determined by calculating R^2.

Gradient of regression line. The research is looking for CSFs that can be associated with a successful implementation. Therefore regression equations displaying a positive slope (indicating a positive association) are selected for further analysis. As a gradient of "1" shows a directly proportional association (i.e. an increase in CSF rating of one unit on the Likert scale would result in an increase of one unit on the benefits scale), and a gradient of zero would indicate no association, Table 5.1 has been compiled to evaluate the strength of the association:

Table 5.1 Strength of association

Gradient	Strength of association
0 to 0.33	weak
0.34 to 0.66	moderate
> 0.67	strong

Significance of the regression line. The amount of evidence required to accept that an event is unlikely to have arisen by chance is known as the significance level, or critical p-value. When conducting linear regression, the t-score which is a function of the slope of the regression line and the Standard Error (SE) of the slope, is matched to the relevant distribution table to determine the p-value.

Stattrek (2009) provides the following method for determining if a significant association exists between an Independent Variable (IV) and a Dependent Variable (DV):

Step 1: State the hypothesis

Hypothesis: if there is a significant linear association between the IV and DV the slope will not be zero.

Null hypothesis: If the association is not significant the slope will equal zero.

Step 2: Formulate an analysis plan

The significance level is chosen to be 0.05 (corresponding to 95% confidence interval as suggested by Leedy and Ormrod (2005, p270)).

A linear regression t-test is performed to determine whether the slope of the regression line differs significantly from zero.

Step 3: Data analysis

To apply the linear regression t-test to the sample data the following calculations are performed:

a) the slope and SE (standard error) of the slope are calculated;
b) the degrees of freedom (DF) is calculated as n-2;
c) the t-sore (T Stat) is determined by dividing the slope by the SE; and
d) the p-value is calculated using the t-score and DF, specifying a two tailed distribution (+ve & -ve) in the calculation.

Step 4: Interpret results

If the p-value is less than 0.05 the null hypothesis is rejected and the findings are categorised as being statistically significant.

Regression fit. The degree to which future outcomes are likely to be predicted by the model (and hence the reliability of the model) is evaluated using the guide recommended by Ratner (2009), reproduced in Table 5.2. The corresponding significance levels are included in the table. These significance levels are calculated using the correlation coefficient (*r*), on the basis of the Fisher *Z* transformation as described by Johnson (2000, p373) for a single-sided significance. (Refer to Appendix G: Sample Calculations for details.)

Table 5.2 Goodness of fit guide

Value of r	Corresponding value of R^2	Goodness of fit	Significance
-0.3 to 0 & 0 to 0.3	0 to 0.09	weak	0 to 87.70%
-0.3 to -0.7 & 0.3 to 0.7	0.09 to 0.49	moderate	87.70% to 99.94%
-0.7 to -1 & 0.7 to 1	0.49 to 1	strong	99.94% to 100%

5.3 Market Research Results

5.3.1 Survey response

Of the 79 companies targeted, an initial telephone conversation was conducted with the identified individual/their personal assistant/or other relevant individual in 44 (58%) of the cases prior to the questionnaire being sent. During the initial telephone conversation five targeted respondents (or their personal assistants) stated that they were unable (or unwilling) to participate in the study. Of the 74 questionnaires that were emailed out, six emails were returned as undelivered due to invalid email addresses or the email being blocked by the recipient's server. Despite efforts to contact these individuals by telephone, the emails were unable to be re-sent. Of the emails that did reach their target, four emails were received from non-respondents stating that they did not have the knowledge or were unable to divulge the required information. Within the first week, eight completed questionnaires were received from respondents. After sending out the first reminder, a further seven responses were received. The final email reminder yielded a further three responses. 46 targeted participants did not respond to the emails that were sent. The timing of the responses is shown in Figure 5.3.

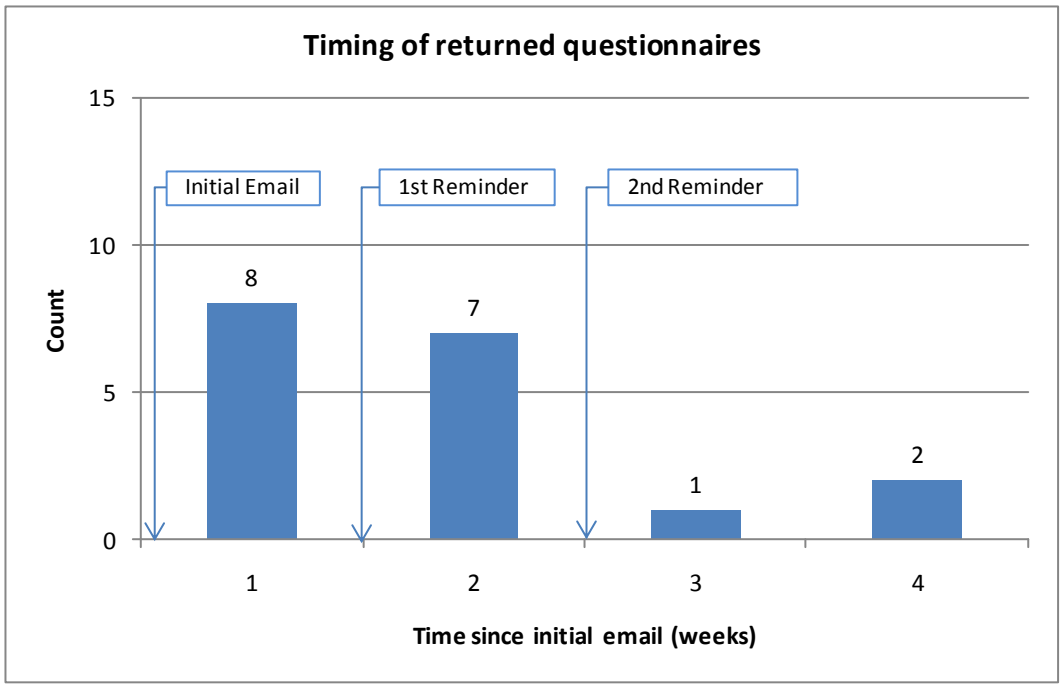


Figure 5.3 Timing of returned questionnaires

In total 18 respondents completed and returned the questionnaire. All questionnaires were confirmed to have been completed correctly. However, in one case answers were unable to be provided for the first two ERP time periods (due to the "go-live" date of 1995 being prior to the respondent's employment date at the company). In another case, answers for the last time period ("year 3") were not completed due to a "go-live" date of early 2008. This lack of data was deemed not to affect the end results and therefore no responses are considered to be ineligible. It does however mean that for each time period a total of 17 responses are reviewed.

The active response rate is given by (Saunders et al, 2003, p157):

$$active\ response\ rate = \frac{\text{total number of responses}}{total\ number\ in\ sample - (ineligible + unreachable)} \qquad (5.3)$$

Applying this equation to the responses received:

$$active\ response\ rate = \frac{18}{79 - (0 + 6)} * 100 = 25\%$$

Ten (55% of the total returned) questionnaires were received from individuals where an initial telephone call was conducted. (This figure neither proves, nor disproves Sheehan's (2001) notion that pre-notification could lead to a higher response rate). Of the 18 responses, 15 (83%) were from companies where the researcher was able to leverage an existing relationship and only three (17%) were from companies where no referral was mentioned in the initial telephone call and/or covering letter. This factor must be kept in mind when analysing the data as it could lead to bias in the results. However, as most of these responses (14) resulted from contacts provided by corporate suppliers/customers, and not from the group where the same consultancy was involved, the risk of bias in this case is reduced.

Before summarising and analysing the results it first needs to be determined if sufficient feedback has been received from the surveyed population (i.e. is the

response rate sufficient). This is required as a high response rate reflects less of a potential for bias (Hox & DeLeeuw, 1994; Leedy and Ormrod, 2005, pp208-210). The initial feeling of the researcher is that the response rate of 25% appears low. However, having consulted the literature concerning email response rates, a rate of between approximately 20% - 35% should be expected for email questionnaires (Yehuda & Brooks, 2008, Sheehan, 2001, Shih & Fan, 2009). Taking into consideration that these studies show response rates to be on the decline, due to amongst other factors, the rise in email surveys being conducted (Sheehan, 2001). This leads the researcher to conclude that sufficient feedback has been received (keeping in mind that the target population of senior executives are the targets for many research studies and are possibly "over surveyed"). However, in proceeding to the analysis of the results the presence of the identified response bias and sampling bias must be taken into consideration.

5.3.2 Data consolidation

The data from the questionnaires are consolidated and displayed in Table 5.3. All questionnaire responses have been deemed to be satisfactorily completed and have therefore been included in this section. Companies have been randomly renamed "A" to "R" to ensure the anonymity of the respondents. As indicated in section 5.3.1 it should be noted that the responses for company "A" and company "R" have not been completed for the full post "go-live" periods (reducing the sample set to 17 for each of the three time periods).

Table 5.3 Consolidated survey responses

Participant Company	A	B	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
Participant Position in Company	GM - Information Services	Managing Director	CIO	Financial Director	Group Logistics and Distribution Executive	Group SAP Manager	ERP Optimization Manager	Manager Procurement	IT Manager	CIO	Group ICT Manager	Metal Accounting Manager	Supply Chain Director/Acting MD	CIO	Demand & Supply Planning Manager	Supply Chain Planning Manager	Strategic Sourcing	Information Technology Manager
Primary Industry	Basic Materials - Chemicals	Consumer Goods - Food & Beverage	Industrials - Construction & Materials	Consumer Goods - Food & Beverage	Health Care - Pharmaceuticals	Industrials - Diversified Industries	Consumer Goods - Tabacco	Consumer Goods - Food & Beverage	Industrials - Chemicals	Technology - Computer Services	Basic Materials - Mining & Chemicals	Basic Materials - Mining of Platinum & Precious Metals	Consumer Goods - Personal & Household	Industrials - Containers & Packaging	Consumer Goods - Food & Beverage	Consumer Goods - Food & Beverage	Consumer Goods - Food & Beverage	Consumer Goods - Food & Beverage
Questions Applicable to:																		
Entire Corporation	X	0	X	X	X	0	0	0	0	X	X	0	X	X	0	0	0	0
Division/Business Unit	0	0	0	0	0	X	0	X	X	0	0	0	0	0	X	X	X	X
Manufacturing Plant	0	X	0	0	0	0	X	0	0	0	0	X	0	0	0	0	0	0
Main Manufacturing Processes																		
Project	0	0	0	0	0	X	0	0	0	X	X	0	0	0	0	0	0	0
Job Production	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0
Batch Production	X	0	0	X	0	0	X	X	X	0	0	X	0	X	X	X	X	X
Assembly Line	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Continuous Production	0	X	0	0	X	0	0	0	0	0	0	0	X	0	0	0	0	0
Annual Revenue																		
<R500 million	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0
R500million - 1billion	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R1billion - R5billion	0	0	0	0	X	0	0	0	0	0	X	0	X	0	0	0	X	X
R5billion - R10 billion	X	X	X	0	0	0	0	X	0	0	0	0	0	0	X	0	0	0
> R10 billion	0	0	0	0	0	X	X	0	0	X	0	X	0	X	0	X	0	0
1) Enabling Systems in Place																		
Enterprise resource planning (ERP)	5	4	5	5	5	5	4	4	5	4	4	5	5	5	5	5	4	5
Forecasting/demand planning software	5	5	3	5	4	5	5	5	4	2	4	3	5	4	5	4	5	3
Advanced planning & scheduling (APS)	5	3	1	4	5	5	4	5	4	2	2	2	3	4	5	3	3	3
Quality management system (QMS)	1	5	3	4	5	4	5	4	5	1	3	5	4	3	5	4	4	3
Customer relationship management (CRM)	1	5	1	2	2	4	2	4	3	4	1	5	2	2	4	4	3	1
Supplier relationship management (SRM)	1	4	2	2	3	4	5	3	3	4	2	5	2	1	1	2	3	1
Business intellegence system (BI)	5	5	5	3	4	4	1	4	4	3	3	5	4	5	5	3	3	5
2) ERP system implemented:	SAP	SAP	SAP	JDE	BAAN	SAP	SAP	BPCS	Protean	SAP	JDE	SAP	MFGPro	JDE	SAP	SAP	MFGPro	JDE
3) Year that ERP system went live:	2008	1999	1996	2000	1996	2002	1999	2003	2001	2003	2003	2000	<1995	2003	2005	<1995	2001	1995
4) Number of legacy systems:	>20	1-5	10-15	1-5	1-5	5-10	1-5	1-5	1	1-5	1-5	1-5	1-5	5-10	1-5	15-20	5-10	1
5) Previous ERP system in place?	Yes	Yes	No	No	No	No	Yes	Yes	No	Yes	No	No	No	No	Yes	No	Yes	No
6) Critical Success Factors in Place																		
Business planning, vision & strategy	4	4	3	4	4	4	4	4	3	3	4	4	4	3	4	4	3	4
Business process re-engineering	1	4	2	3	3	4	3	4	3	3	2	4	4	4	4	4	4	3
Change management	4	2	2	3	4	4	3	4	3	3	4	4	4	4	4	5	2	4
Education and training	4	4	3	4	3	4	4	4	3	3	4	4	3	4	3	5	2	4
Effective communication	4	4	4	4	2	3	3	3	3	3	4	4	3	3	3	4	2	4
Effective ERP team composition	4	3	3	4	3	4	4	4	3	3	4	4	4	4	4	4	2	4
Minimum customisation	4	1	2	3	2	2	2	3	2	1	3	4	4	3	3	4	3	3
Project management	4	4	4	4	3	4	4	4	3	3	2	4	4	4	4	5	2	4
Software development, testing & troubleshooting	4	3	3	4	4	4	4	4	3	4	2	4	3	3	4	5	3	3
Top management commitment	4	1	4	4	3	4	4	4	3	3	4	4	4	3	4	4	4	4

Consolidated survey responses continued....

Participant Company	A	B	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
ERP Benefits Year 1																		
Financial Benefits																		
Operating and administration costs	-1	0	1	2	0	-2	0	1	-1	2	2	2	1	0	0	0	1	
Stock levels	0	0	0	1	0	2	1	1	-1	1	0	2	1	-1	0	0	0	
Turnover/Sales	0	0	1	0	0	0	0	1	0	2	0	0	1	0	0	1	0	
IT operating costs	-1	-2	2	-2	-1	0	-2	0	-1	2	-1	1	1	-2	0	-1	0	
Internal Business Benefits																		
Manufacturing productivity and efficiency	0	0	0	1	0	0	2	0	-1	1	0	2	1	0	0	0	1	
Resource utilization (Human & machine)	0	0	2	1	0	1	0	1	0	1	2	0	1	0	0	1	1	
Enhanced business processes	-1	1	2	1	0	2	2	1	-1	2	3	2	1	1	0	2	0	
Data/transaction processing time	0	2	1	2	0	2	0	1	-1	2	2	2	3	2	0	1	2	
Inventory turns	0	0	0	0	0	1	1	2	-1	2	1	2	1	-1	0	0	1	
Accuracy and timeliness of information	1	0	1	1	0	3	0	2	-1	2	3	3	3	0	1	2	0	
Internal information sharing	1	2	1	1	0	1	1	3	0	2	2	3	2	1	1	1	0	
Manufacturing lead times	0	0	0	1	0	2	1	0	0	2	0	2	1	0	0	0	1	
Integration of applications	2	2	1	1	0	3	0	1	1	2	1	2	3	2	1	2	1	
Improved decision making	2	0	2	1	0	1	1	2	1	2	1	2	2	-1	1	0	0	
Vendor performance	0	-1	3	0	0	1	1	1	0	2	0	2	1	0	0	1	0	
Customer Benefits																		
Customer service	0	0	1	0	0	0	-1	1	0	2	0	2	1	0	0	1	0	
On time shipments	1	0	1	0	0	1	1	1	0	2	1	0	1	-1	0	1	0	
External information sharing	1	0	2	0	0	2	-1	1	0	2	2	2	1	0	0	0	0	
Reduced service (delivery) lead times	0	0	1	1	0	1	0	1	0	2	1	0	1	0	0	1	0	
Learning and Growth Benefits																		
Adherence to best practice work patterns	-1	0	2	1	0	2	3	2	1	1	0	2	3	1	1	2	0	
Organisational learning	2	1	3	1	0	3	2	1	1	1	0	2	3	2	1	1	0	
Effectiveness of employees	-1	0	1	0	-1	-1	-1	2	-1	1	2	1	3	0	1	1	0	
Roll out of a common vision	0	0	3	0	0	2	0	2	1	1	1	1	3	0	1	1	0	
ERP Benefits Year 2																		
Financial Benefits																		
Operating and administration costs	1	0	2	2	1	-2	1	1	2	2	2	3	1	1	0	1	1	
Stock levels	1	1	0	2	1	3	2	2	0	2	0	2	2	1	0	-1	1	
Turnover/Sales	0	0	1	0	0	1	1	1	0	2	0	0	2	0	0	1	0	
IT operating costs	-2	-1	2	-1	-1	0	-1	1	0	2	0	1	2	-1	0	-2	0	
Internal Business Benefits																		
Manufacturing productivity and efficiency	0	1	1	2	1	0	2	1	0	2	0	3	1	1	0	0	1	
Resource utilization (Human & machine)	0	1	2	2	1	2	1	1	0	1	3	0	1	0	0	2	0	
Enhanced business processes	1	1	2	1	1	3	3	2	0	2	2	2	2	2	1	3	1	
Data/transaction processing time	1	2	2	3	2	2	1	1	0	2	2	3	3	3	1	1	1	
Inventory turns	0	1	0	1	0	2	2	2	0	2	0	2	1	0	0	0	1	
Accuracy and timeliness of information	2	1	2	2	1	3	2	2	0	2	3	3	3	3	2	2	1	
Internal information sharing	2	2	2	2	1	2	2	2	0	2	2	3	2	2	2	1	0	
Manufacturing lead times	0	0	0	1	1	3	2	0	1	2	0	2	1	0	0	0	2	
Integration of applications	2	2	2	2	2	3	0	2	1	2	1	3	3	3	2	2	2	
Improved decision making	2	0	2	2	1	2	2	2	2	2	1	3	2	1	1	1	0	
Vendor performance	0	0	3	1	0	2	2	1	1	2	0	2	1	0	0	1	0	
Customer Benefits																		
Customer service	1	0	2	1	0	1	1	2	2	2	1	3	2	1	0	2	0	
On time shipments	2	0	1	1	1	1	2	2	2	2	0	0	2	1	0	1	0	
External information sharing	2	0	2	1	1	2	1	2	1	2	2	3	1	1	1	0	0	
Reduced service (delivery) lead times	0	0	2	1	1	2	1	1	2	2	0	0	1	0	0	1	1	
Learning and Growth Benefits																		
Adherence to best practice work patterns	0	1	3	2	1	2	1	2	2	2	0	3	3	2	2	2	0	
Organisational learning	2	1	2	2	1	3	1	2	2	2	0	3	3	3	1	2	0	
Effectiveness of employees	0	1	2	1	0	1	1	1	1	2	2	2	3	1	1	2	1	
Roll out of a common vision	0	0	3	1	1	2	1	1	2	2	1	3	3	1	2	1	0	

Consolidated survey responses continued....

Participant Company	A	B	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
ERP Benefits Year 3 Onwards																		
Financial Benefits																		
Operating and administration costs		1	2	3	1	-1	3	1	3	3	2	3	3	2	0	2	1	2
Stock levels		1	0	2	2	2	3	3	1	2	0	2	2	2	0	-2	2	2
Turnover/Sales		0	1	0	1	1	2	1	0	3	0	0	2	0	0	1	1	3
IT operating costs		-1	3	-1	0	0	0	2	1	3	1	1	3	0	0	-2	0	2
Internal Business Benefits																		
Manufacturing productivity and efficiency		1	1	2	1	0	2	2	1	3	0	3	2	1	0	0	0	2
Resource utilization (Human & machine)		1	2	2	1	3	3	1	0	2	2	0	2	1	0	2	0	1
Enhanced business processes		1	3	2	2	3	3	3	1	2	2	2	2	2	2	3	2	2
Data/transaction processing time		2	3	3	3	3	2	1	1	2	2	3	3	3	2	1	0	3
Inventory turns		1	0	1	1	3	3	2	1	2	0	2	1	1	0	0	0	1
Accuracy and timeliness of information		1	3	3	2	3	3	2	2	3	3	3	3	3	3	2	0	3
Internal information sharing		2	2	3	1	3	3	2	2	2	2	3	3	2	2	1	0	3
Manufacturing lead times		0	0	2	1	3	3	0	2	2	0	2	1	1	0	0	0	2
Integration of applications		2	3	2	3	3	1	3	2	3	1	3	3	3	3	2	3	3
Improved decision making		1	3	3	2	3	3	2	2	3	1	3	2	3	1	2	0	2
Vendor performance		1	3	2	1	2	3	1	1	2	0	2	2	1	0	1	0	2
Customer Benefits																		
Customer service		0	3	2	0	1	2	3	2	3	1	3	3	2	0	2	1	2
On time shipments		0	2	2	2	2	3	2	2	3	0	0	2	2	0	1	1	2
External information sharing		0	2	1	1	3	2	2	1	3	2	3	1	2	2	0	0	1
Reduced service (delivery) lead times		0	2	2	1	2	1	1	2	2	0	0	1	1	0	1	1	2
Learning and Growth Benefits																		
Adherence to best practice work patterns		2	3	2	2	2	1	2	2	3	0	3	3	2	2	2	0	2
Organisational learning		0	3	2	2	3	0	3	2	2	1	3	3	3	2	3	0	2
Effectiveness of employees		1	3	2	1	2	3	1	2	2	1	3	3	2	1	2	0	2
Roll out of a common vision		0	3	2	1	3	1	1	2	2	1	3	3	1	3	1	0	2

Note: the rating scale that has been used to convert the data for question 1 (degree of enabling systems in place) is:

Scale	Degree of Implementation
5	Extensive
4	Moderate
3	Some
2	Little
1	Not at All

The impact scales for the ERP benefits, and the CSFs, remain the same as on the questionnaire:

ERP Benefits Key:

Scale	Performance Impact Scale
3	High Performance Improvement
2	Medium Performance Improvement
1	Low Performance Improvement
0	No Effect on Performance
-1	Low Performance Reduction
-2	Medium Performance Reduction
-3	High Performance Reduction

CSF Key:

Scale	Extent Adopted
4	To a great extent
3	Somewhat
2	Very little
1	Not at all

5.3.3 Background factors and sources of bias

The main objective of the market research was to collect sufficient data, to test the four hypotheses. However, before the data can be analysed the factors that may have influenced the respondents' answers (apart from the ERP system itself) and therefore led to bias within the data set need to be determined. Through this analysis the validity of the data set and resulting conclusions can be more accurately understood.

The factors identified through the preceding sections of the research that could potentially lead to bias and were therefore built into the questionnaire design are:

1. The respondent's position within the company.
2. The organisational level at which the respondent is reporting results.
3. The size (in terms of revenue) of the companies involved in the study.
4. The industries from which responses were received.
5. The main manufacturing processes synonymous with the surveyed companies.
6. The enabling systems in place that could impact performance measures, otherwise attributed to having an ERP system in place.
7. The brand of ERP system implemented.
8. The year that the ERP system went live.
9. The number of legacy systems in place prior to the ERP system implementation.
10. The presence of a previous ERP system within the surveyed firms.

These potential sources of bias are analysed in detail in the following subsections:

Respondent's position in the organisation

The diagram below shows the positions held by the respondents within the organisations they represent. (The job descriptions given by the respondents have been consolidated into common job titles.) Based on the diagram below, the following conclusions are drawn:

1. All of the positions detailed below indicate that the respondent is in a position of adequate seniority to provide an accurate account of the impact of the ERP system on their company's performance.
2. There is a variety of positions within the organisations represented so as not to bias the results towards a particular job stream or function.

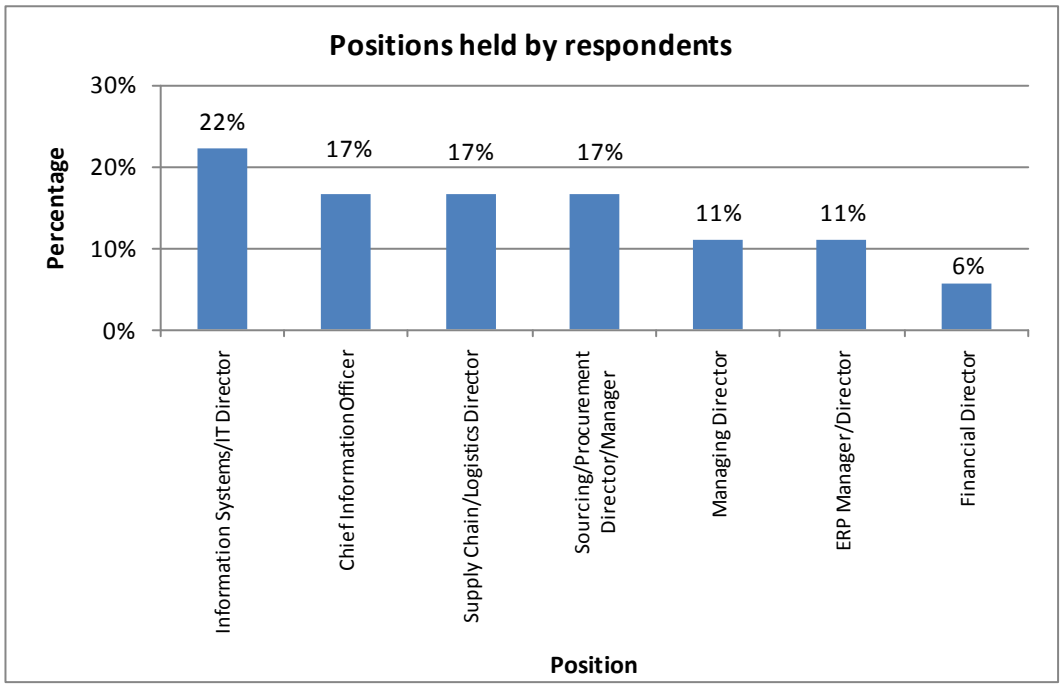


Figure 5.4 Positions held by respondents

Organisational reporting level

Figure 5.5 shows at what level within the organisation the respondents have answered the questionnaire. This classification is used to determine if the results received can be viewed as being applicable to organisations in their entirety or only to elements (i.e. divisions or plants) within the organisation. The feedback indicates that 44% of respondents are reporting results at an overall company

level, and the rest of the respondents are reporting results at a lower level. It can be argued that this spread of responses may lead to a more representative data set across the various levels within an organisation: however it must be kept in mind that the objective of the research is to investigate the impact at an overall organisational level. Having said this, it must be stressed that the responses at the lower levels are deemed to be valid as they contribute directly to overall organisational performance.

Taking the above discussion into consideration, no responses are excluded from the data set based on the reporting level, however there is a potential for bias in the results due to the feedback from a plant or division not necessarily being representative of the entire organisation.

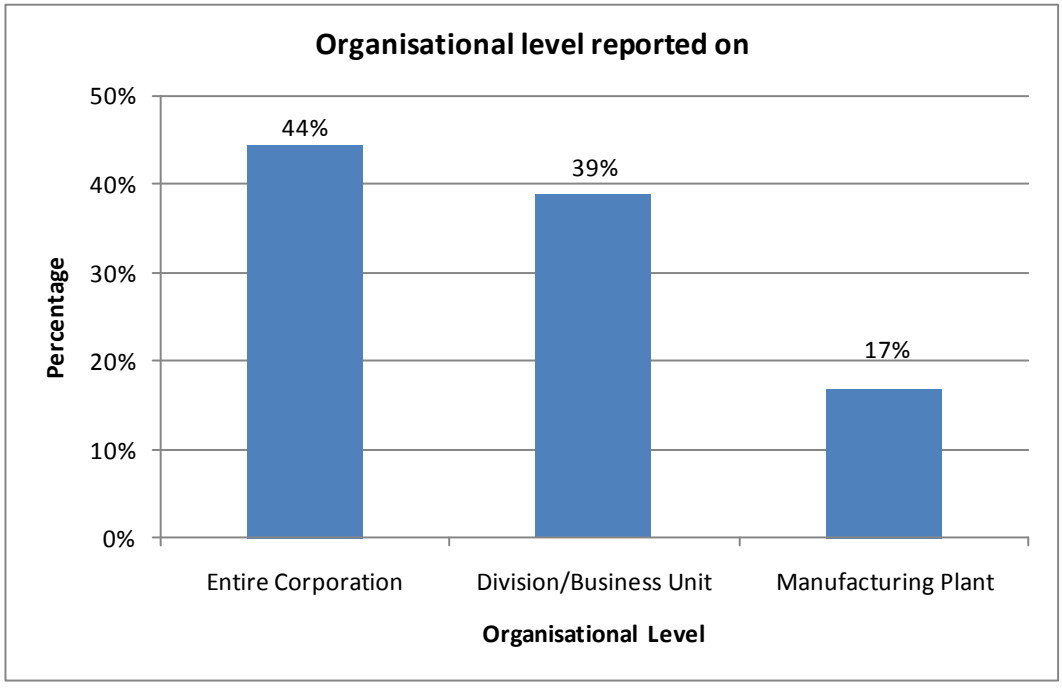


Figure 5.5 Organisation level reported on

Annual revenue

The size of the organisation (categorised by annual revenue) needs to be considered to identify if the results could be biased in favour of either larger or smaller enterprises. This is important because factors applicable to large organisations achieving success (for example, capital spend, resource availability, and previous legacy system experience) may not be available to smaller organisations. Likewise, factors that could lead to smaller organisations achieving benefits (for example, flexibility and ease of culture shift) might not be so easily achievable within larger corporations. However, as this research is not concerned primarily with differentiating the results based on organisation size, no responses are excluded based on this differentiator, but it could be used to determine the applicability of the findings to future research.

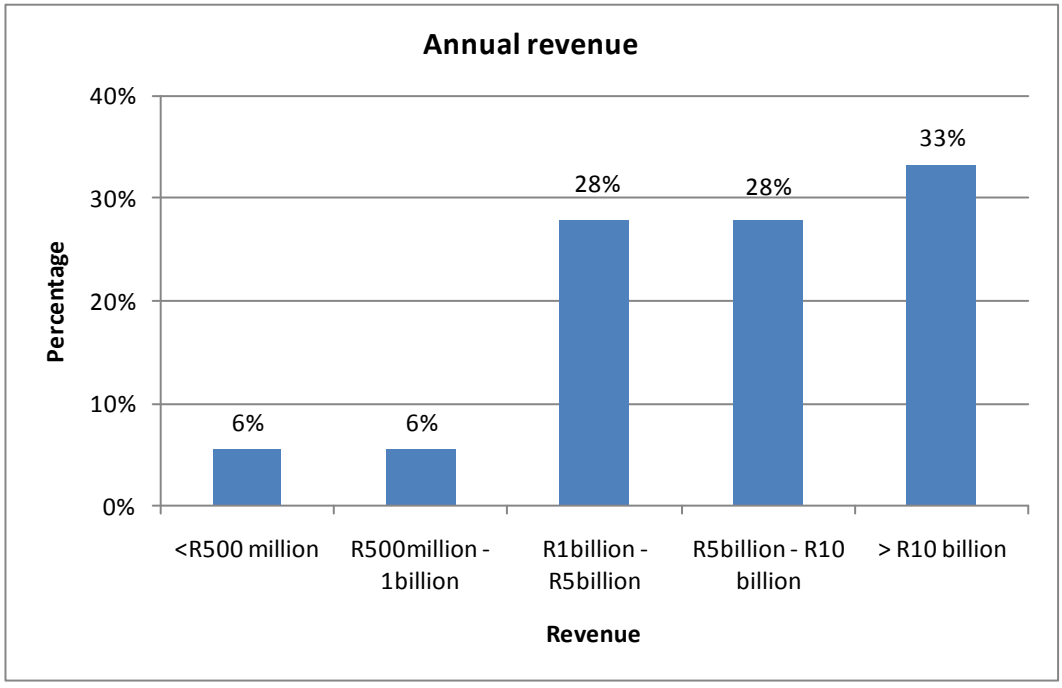


Figure 5.6 Annual revenue

Analysis of the annual revenue of the organisations represented shows that 88% of the responses apply to organisations/business units/plants with an annual revenue of > R1 billion. It is therefore concluded that the results could be biased towards organisations with an annual revenue of greater than R1 billion and care should be taken when drawing deductions about smaller organisations.

Industry segmentation

The descriptions of the industries represented have been consolidated according to the sector descriptions detailed by Hutton et al (2008, pp38-49). Classifying the industry breakdown in this manner provides five broad sectors represented by the sample set. This representation is deemed to be sufficient as it covers five of the seven major manufacturing sectors identified by Hutton et al (2008). The only two major manufacturing sectors not represented are, Oil & Gas and Automotive. However, the spread of the data shows that 50% of the respondent companies service the Consumer Goods sector. This could lead to bias in favour of this sector and needs to be kept in mind when analysing the results.

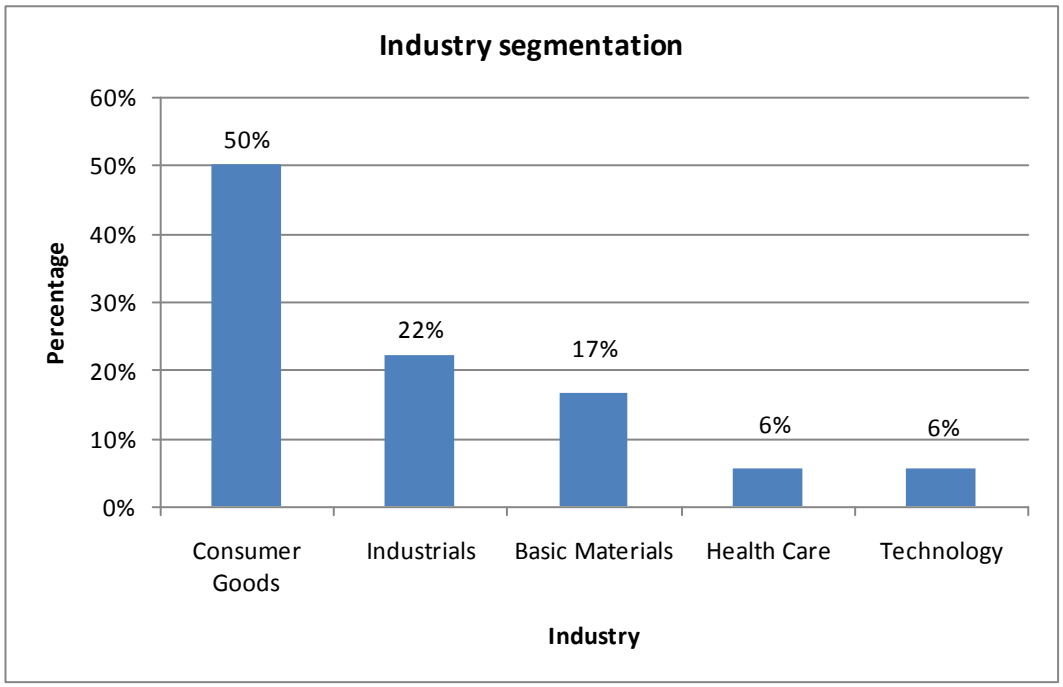


Figure 5.7 Industry segmentation

Primary manufacturing process

Linked to the industry classification above, is the main manufacturing process used by each organisation. The key points that can be observed from Figure 5.8 are:

1. The bulk of organisations represented make use of predominately batch production processes. This corresponds to the main industries represented (i.e. Consumer Goods and Industrials).
2. No assembly line based operations are represented. A link can be drawn here (although not entirely attributed) to the absence of automotive companies within the sample set.

Due to this high representation of batch production organisations represented in the sample, the results may be biased towards companies within this category.

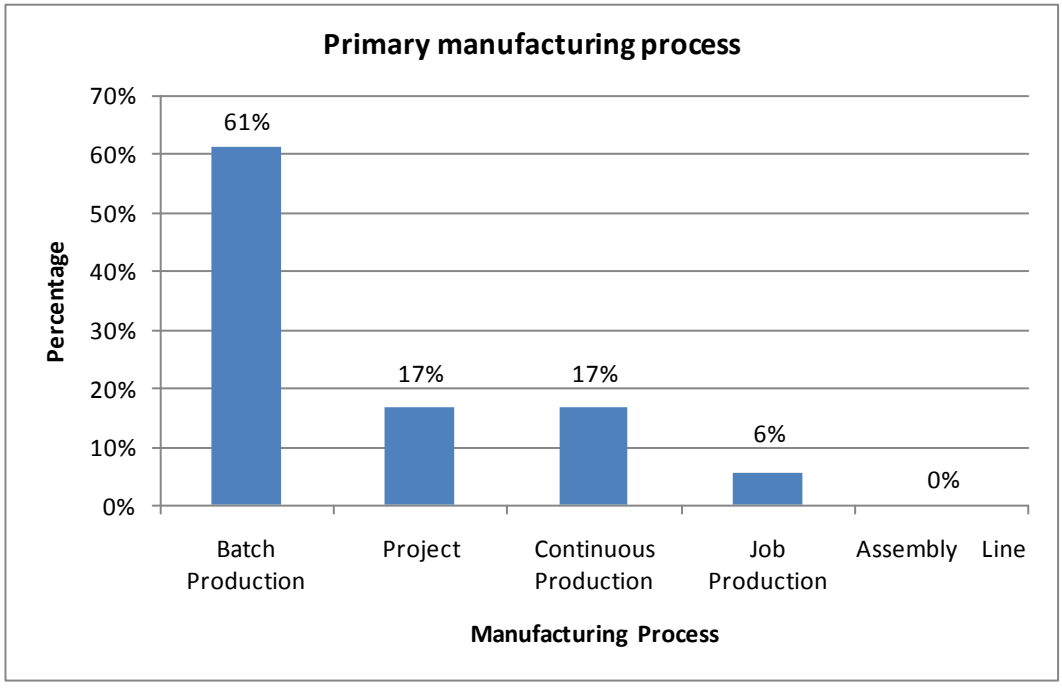


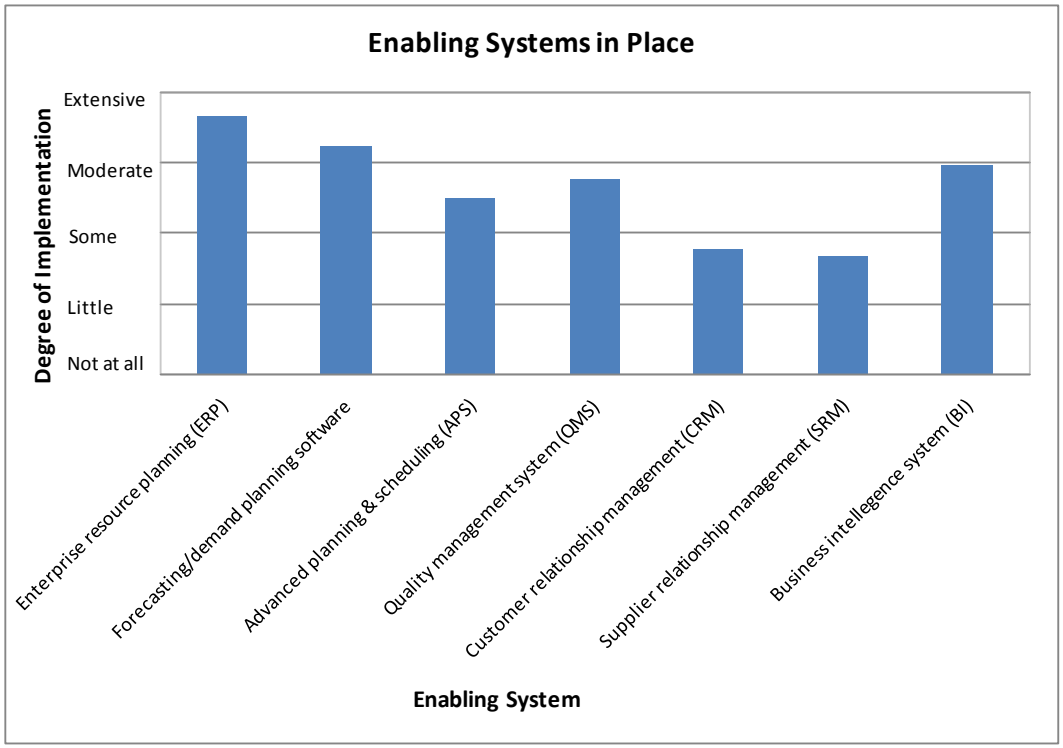
Figure 5.8 Manufacturing process

Enabling systems in place

In both the literature review (for example, Hendrick et al, 2007) and structured interviews (section 4.4) the impact of enabling systems on organisation performance is discussed, and the risk of attributing benefits of these enabling

systems exclusively to ERP systems is noted. To investigate this source of bias in the sample set, the degree to which each enabling system (including ERP) has been implemented is tested. The average (mean) responses are displayed graphically below. The following can be deducted from analysing this graph in conjunction with the raw data:

1. The average degree of ERP implementation tends towards "extensive". In fact analysing the raw data set shows no companies within the sample set have implemented ERP to less than a "moderate" extent. This supports the inclusion of all the responses in the analysis of the results and does not provide a basis on which to exclude any of the respondent questionnaires.
2. All of the respondent organisations have three or more enabling systems (outside of ERP) implemented to a greater or lesser extent, which contributes to the averages shown in the graph below. Based on this high presence of enabling systems there is a potential risk that benefits achieved via the combination of operating on an ERP system integrated with these enabling systems could be attributed exclusively to the ERP system.



Note: "extensive" = complete implementation of total software functionality across entire organisation

Figure 5.9 Enabling systems in place

Brand of ERP system implemented

The first assumption of the research states that because ERP systems from the main stream software vendors have a feature overlap of approximately 60-70% (Gupta and Kohli, 2004, p3), this research does not differentiate results based on the brand of system in place. However, by determining the ERP system implemented the following can be established:

1. If the systems implemented at the respondent companies are from reputable vendors and can therefore be deemed to have the assumed functionality overlap.
2. If there is potential for bias in the results towards a particular brand of ERP system (due to the 30-40% of product specific functionality).

Figure 5.10 reveals that six brands of ERP systems were implemented within the sample set. All of these ERP systems are from main stream vendors and therefore no results are excluded on this basis. As 50% of the respondents implemented SAP, there is potential for bias towards this brand.

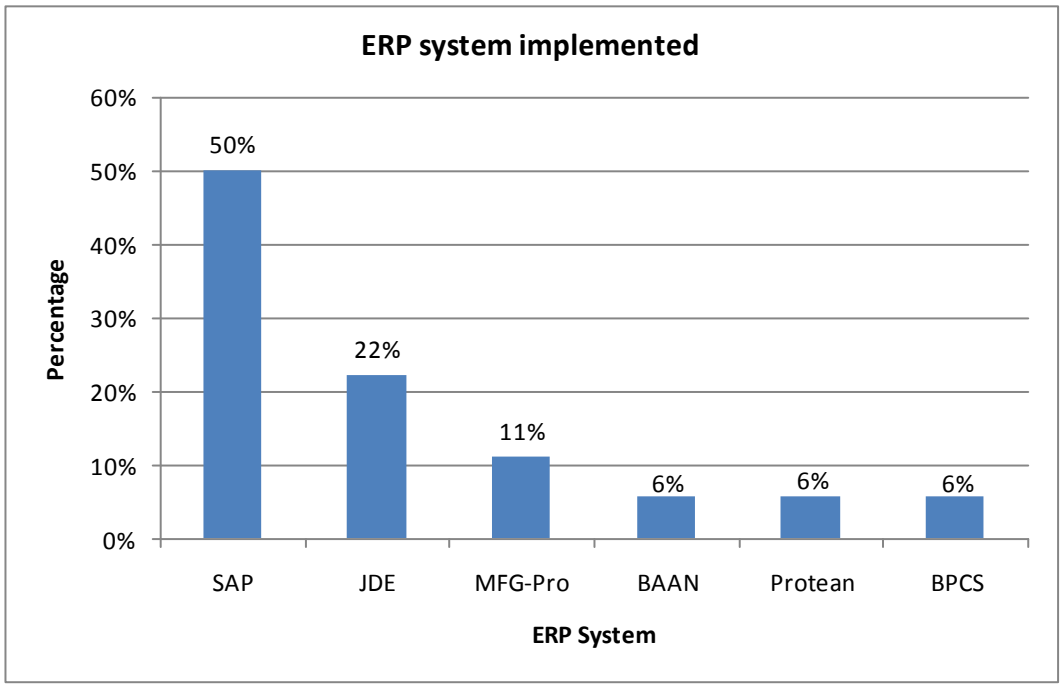


Figure 5.10 ERP system implemented

Year of "go-live"

As described in the literature (Hendricks et al, 2007) the year that the ERP system was implemented could have an effect on the benefits achieved. This can be attributed to many factors, not least the evolution of technology and ERP systems over the last decade. Whereas this research does not set out specifically to investigate these implementation period impacts, it is a factor that must be taken into account when analysing the results to ensure that bias does not exist towards ERP systems that have been implemented within a specific time period.

Displaying the ERP implementation "go-live" dates graphically reveals an acceptable spread of dates up until 2005. However, only 6% of the respondents went live post 2005 indicating that results may be biased to implementations prior to 2006.

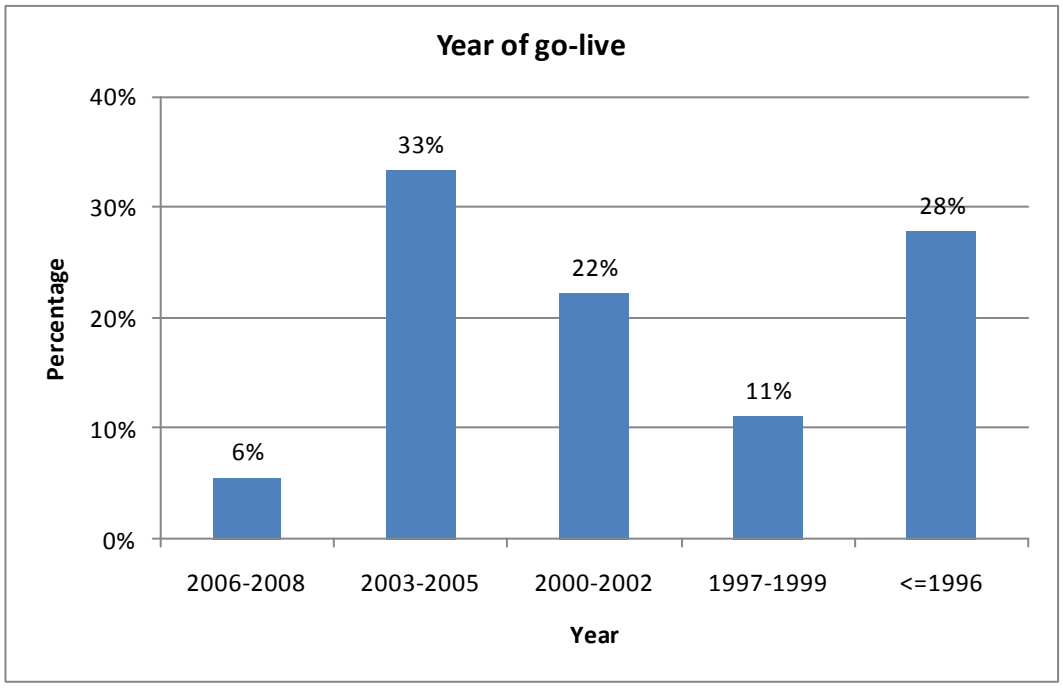


Figure 5.11 Year of "go-live"

Number of legacy systems in place

The comments from the structured interviews (see section 4.4.1) indicate that the IT base from which a company is moving could influence the ERP benefits that

are achieved surrounding IT operating costs. Specifically, a company previously operating in a multi-legacy system, highly supported environment should achieve cost benefits whereas a company previously operating on a low IT base should expect an increase in IT costs. Analysing the diagram below shows that all companies had legacy systems in place prior to the ERP system. However, the varying levels of legacy systems in place could lead to bias within the results (tending towards companies with between two and five legacy systems in place).

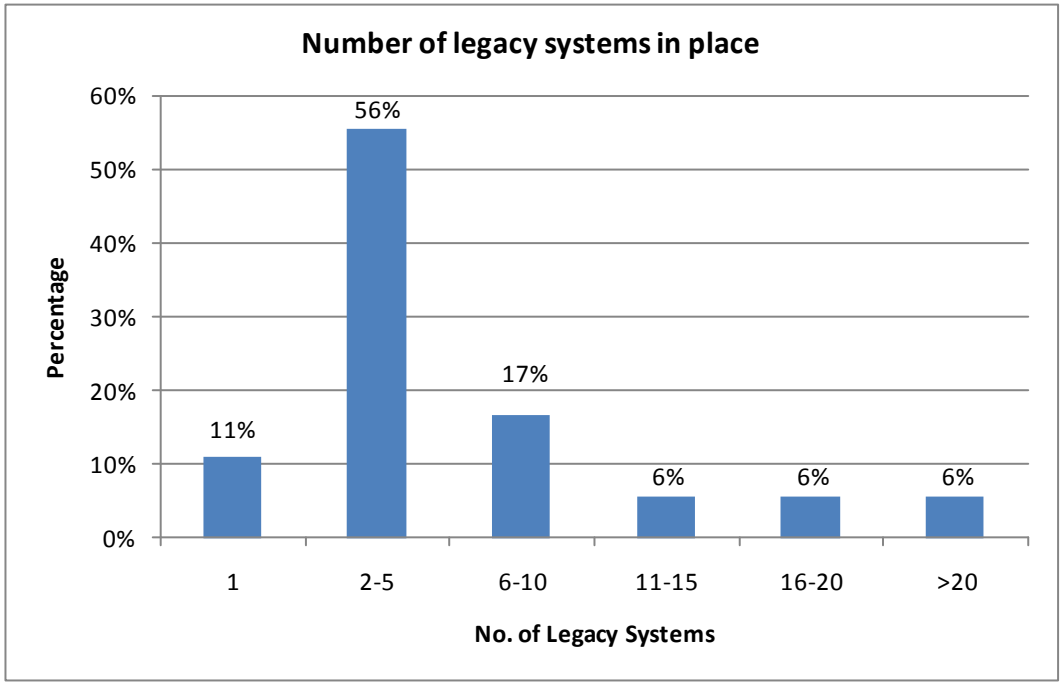


Figure 5.12 Number of legacy systems in place

Prior ERP system in place

The pilot study (see Appendix F: Market Research Questionnaire Design) revealed the possibility that some companies within the sample set may have transitioned to their current ERP system from a previous ERP system/version. No literature was found to indicate the benefits or concerns with such a transition. However, as in the case of the number of legacy systems in place, moving from one ERP system to another could have an impact on the IT operating costs that are experienced. The results show that 39% of respondent organisations did transition to their current ERP systems from an early ERP system/version. This could present a risk of bias, when analysing IT costs.

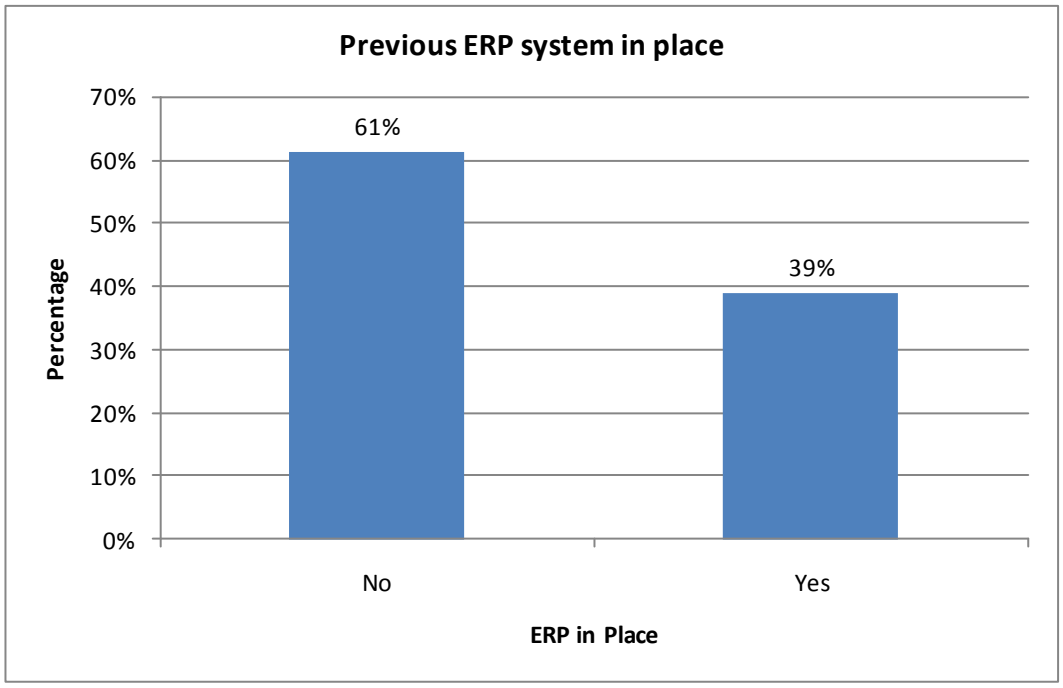


Figure 5.13 Previous ERP system in place

Summary of background factors and sources of bias

The above analyses and discussions provided no convincing evidence for excluding any of the responses from the sample set. However, the following sources of potential bias were noted:

1. Bias due to respondents reporting results at a division or plant level which are not representative of the entire organisation.
2. Bias towards organisations with an annual revenue of greater than R1 billion.
3. Bias towards organisations in the Consumer Goods industry segment.
4. Bias towards industries focused on batch production processes.
5. Bias due to benefits resulting from operating on the combination of an ERP and enabling systems, being attributed exclusively to the ERP system.
6. Bias towards companies who have implemented SAP.
7. Bias towards organisations with implementations going live prior to 2006.
8. Bias due to the number of legacy systems in place.
9. Bias due to operating on a previous ERP system/version.

5.3.4 Nature of the data

As discussed in section 5.2.2 the data can be described as interval in nature. However, due to the relatively small sample size (18 responses) the distribution of the data cannot be established with any certainty. To facilitate the choice of statistics, the Student's t-distribution has been assumed for the analysis and interpretation of the results.

5.3.5 Application of descriptive and inferential statistics

Section 5.2.2 described the methodology, and the relevant statistics, required to assess the data. This section shows the results of applying the statistics to the data set. Data tables are laid out according to the objective and sub-problem they aim to address.

Note: an example of the critical calculations used in constructing the various tables is shown in Appendix G: Sample Calculations.

Survey results for objective 1

Step 1: Establish the level to which benefits have been obtained by selected SA manufacturing firms, over the three year post "go-live" period

Microsoft Excel was used to calculate the mean values for each of the benefits across the three time periods. Upper and lower confidence limits have been calculated for the same time periods, using the Student's t-distribution. Table 5.4 displays these results. Table 5.5 orders the results according to the level of benefit obtained, to facilitate analysis of the results.

Note: cells are highlighted where the confidence intervals fall below zero.

Table 5.4 Benefit averages and confidence intervals

ERP Benefits Key:

Scale	Performance Impact Scale
3	High Performance Improvement
2	Medium Performance Improvement
1	Low Performance Improvement
0	No Effect on Performance
-1	Low Performance Reduction
-2	Medium Performance Reduction
-3	High Performance Reduction

Perspective	Benefit	Mean			Confidence interval (using Student t dist)					
					Year 1		Year 2		Year 3	
		Year 1	Year 2	Year 3	Lower	Upper	Lower	Upper	Lower	Upper
Financial Perspective	Operating and administration costs	0.47	1.12	1.82	-0.136	1.077	0.546	1.689	1.214	2.433
	Stock levels	0.41	1.12	1.41	-0.036	0.859	0.576	1.659	0.755	2.069
	Turnover/Sales	0.35	0.53	0.94	0.041	0.665	0.161	0.898	0.412	1.470
	IT operating costs	-0.41	-0.06	0.71	-1.093	0.270	-0.726	0.608	-0.060	1.472
	Financial Benefits Average	**0.21**	**0.68**	**1.22**	-0.167	0.579	0.337	1.016	0.783	1.659
Internal Business Perspective	Manufacturing productivity and efficiency	0.41	0.94	1.24	0.003	0.821	0.479	1.404	0.704	1.766
	Resource utilization (Human & machine)	0.65	1.00	1.35	0.286	1.008	0.519	1.481	0.841	1.865
	Enhanced business processes	1.06	1.71	2.18	0.471	1.647	1.269	2.142	1.849	2.503
	Data/transaction processing time	1.24	1.76	2.18	0.674	1.796	1.300	2.229	1.687	2.665
	Inventory turns	0.53	0.82	1.12	0.044	1.014	0.370	1.277	0.607	1.628
	Accuracy and timeliness of information	1.24	2.00	2.47	0.567	1.904	1.555	2.445	2.021	2.920
	Internal information sharing	1.29	1.71	2.12	0.821	1.767	1.309	2.103	1.677	2.559
	Manufacturing lead times	0.59	0.88	1.12	0.179	0.997	0.372	1.393	0.546	1.689
	Integration of applications	1.47	2.00	2.53	1.021	1.920	1.594	2.406	2.161	2.898
	Improved decision making	1.00	1.53	2.12	0.519	1.481	1.118	1.941	1.641	2.595
	Vendor performance	0.65	0.94	1.41	0.135	1.159	0.444	1.438	0.929	1.895
	Internal Business Benefits Average	**0.92**	**1.39**	**1.80**	0.586	1.254	1.119	1.661	1.485	2.120
Customer Perspective	Customer service	0.41	1.24	1.76	0.003	0.821	0.771	1.700	1.204	2.326
	On time shipments	0.53	1.06	1.53	0.161	0.898	0.634	1.484	1.011	2.047
	External information sharing	0.71	1.29	1.53	0.199	1.212	0.858	1.731	1.011	2.047
	Reduced service (delivery) lead times	0.53	0.88	1.12	0.208	0.850	0.481	1.284	0.716	1.519
	Customer Benefits Average	**0.54**	**1.12**	**1.49**	0.216	0.873	0.812	1.423	1.120	1.850
Learning and Growth Perspective	Adherence to best practice work patterns	1.18	1.65	1.94	0.595	1.758	1.135	2.159	1.479	2.404
	Organisational learning	1.41	1.76	2.00	0.896	1.928	1.266	2.264	1.425	2.575
	Effectiveness of employees	0.41	1.29	1.82	-0.220	1.043	0.897	1.691	1.370	2.277
	Roll out of a common vision	0.94	1.41	1.71	0.412	1.470	0.896	1.928	1.168	2.244
	Learning & Growth Benefits Average	**0.99**	**1.53**	**1.87**	0.551	1.420	1.123	1.936	1.441	2.294
	Gross Average	**0.66**	**1.18**	**1.59**	0.340	0.988	0.898	1.459	1.273	1.915

Table 5.5 Ordered benefits

Benefit	Perspective	Mean			Confidence interval (using Student t dist)					
					Year 1		Year 2		Year 3	
		Year 1	Year 2	Year 3	Lower	Upper	Lower	Upper	Lower	Upper
Medium to High Performance Improvement										
Integration of applications	Internal Business	1.47	2.00	2.53	1.021	1.920	1.594	2.406	2.161	2.898
Accuracy and timeliness of information	Internal Business	1.24	2.00	2.47	0.567	1.904	1.555	2.445	2.021	2.920
Enhanced business processes	Internal Business	1.06	1.71	2.18	0.471	1.647	1.269	2.142	1.849	2.503
Data/transaction processing time	Internal Business	1.24	1.76	2.18	0.674	1.796	1.300	2.229	1.687	2.665
Internal information sharing	Internal Business	1.29	1.71	2.12	0.821	1.767	1.309	2.103	1.677	2.559
Improved decision making	Internal Business	1.00	1.53	2.12	0.519	1.481	1.118	1.941	1.641	2.595
Organisational learning	Learning & Growth	1.41	1.76	2.00	0.896	1.928	1.266	2.264	1.425	2.575
Low to Medium Performance Improvement										
Adherence to best practice work patterns	Learning & Growth	1.18	1.65	1.94	0.595	1.758	1.135	2.159	1.479	2.404
Operating and administration costs	Financial	0.47	1.12	1.82	-0.136	1.077	0.546	1.689	1.214	2.433
Effectiveness of employees	Learning & Growth	0.41	1.29	1.82	-0.220	1.043	0.897	1.691	1.370	2.277
Customer service	Customer	0.41	1.24	1.76	0.003	0.821	0.771	1.700	1.204	2.326
Roll out of a common vision	Learning & Growth	0.94	1.41	1.71	0.412	1.470	0.896	1.928	1.168	2.244
On time shipments	Customer	0.53	1.06	1.53	0.161	0.898	0.634	1.484	1.011	2.047
External information sharing	Customer	0.71	1.29	1.53	0.199	1.212	0.858	1.731	1.011	2.047
Stock levels	Financial	0.41	1.12	1.41	-0.036	0.859	0.576	1.659	0.755	2.069
Vendor performance	Internal Business	0.65	0.94	1.41	0.135	1.159	0.444	1.438	0.929	1.895
Resource utilization (Human & machine)	Internal Business	0.65	1.00	1.35	0.286	1.008	0.519	1.481	0.841	1.865
Manufacturing productivity and efficiency	Internal Business	0.41	0.94	1.24	0.003	0.821	0.479	1.404	0.704	1.766
Inventory turns	Internal Business	0.53	0.82	1.12	0.044	1.014	0.370	1.277	0.607	1.628
Manufacturing lead times	Internal Business	0.59	0.88	1.12	0.179	0.997	0.372	1.393	0.546	1.689
Reduced service (delivery) lead times	Customer	0.53	0.88	1.12	0.208	0.850	0.481	1.284	0.716	1.519
No to Low Performance Improvement										
Turnover/Sales	Financial	0.35	0.53	0.94	0.041	0.665	0.161	0.898	0.412	1.470
IT operating costs	Financial	-0.41	-0.06	0.71	-1.093	0.270	-0.726	0.608	-0.060	1.472

Step 2: Build the average ERP benefit results into PNBF graphs to determine if benefits can be expected to increase over time

The data from Table 5.4 are built into PNBF flow graphs to facilitate analysis of the results. These graphs are displayed for each benefit, grouped according to the ERP Time-Based BSC perspective they fit into.

Financial benefits PNBF graphs:

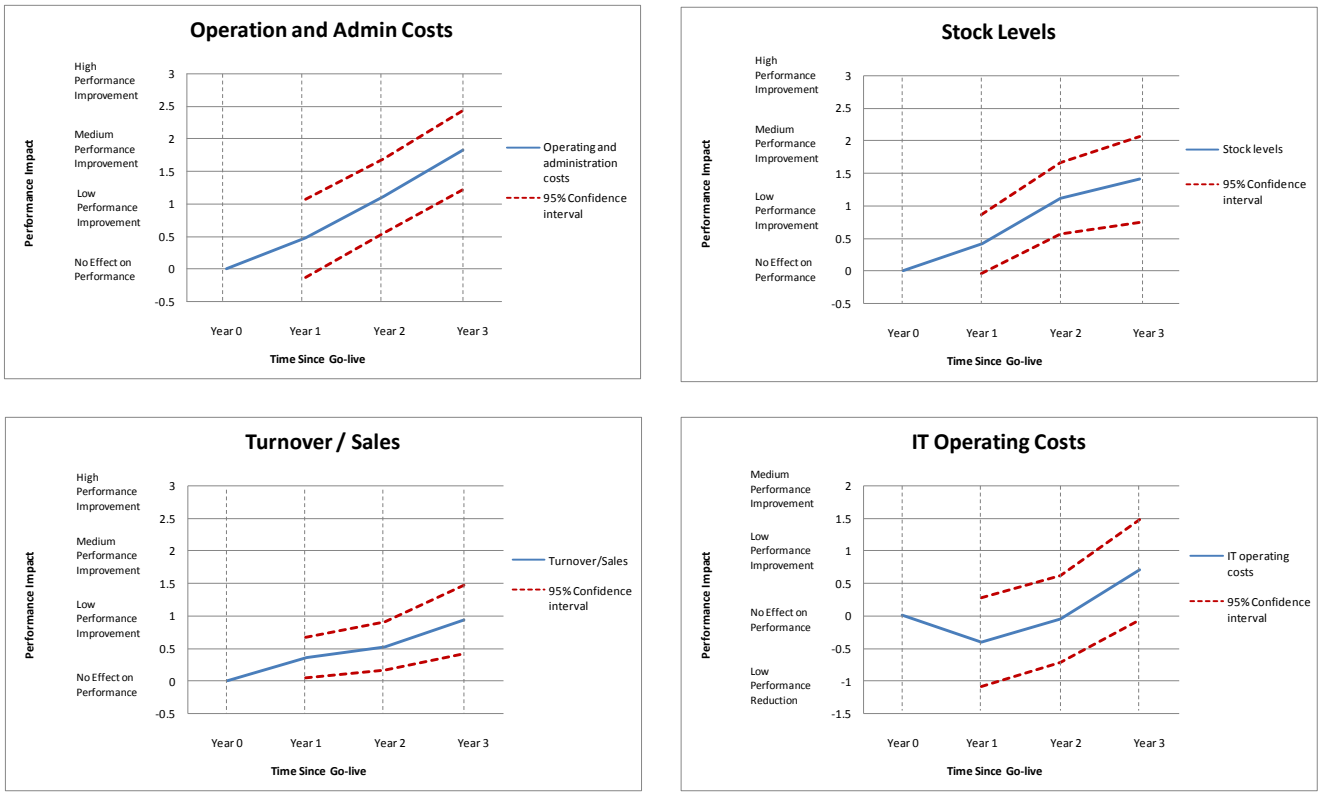
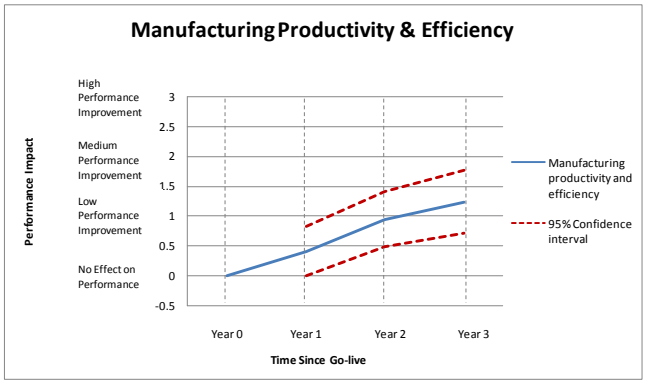
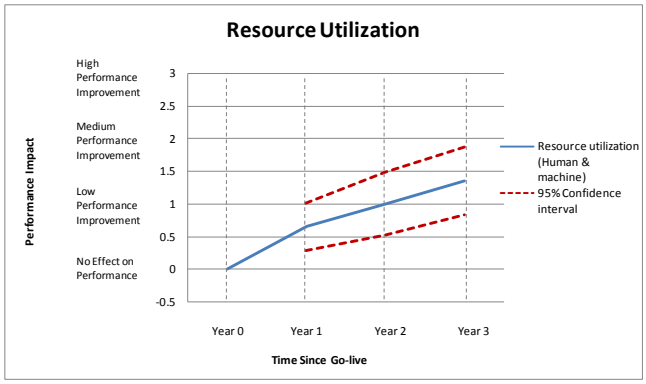
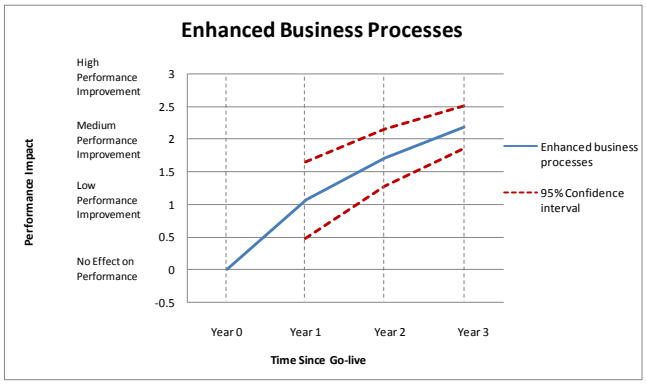


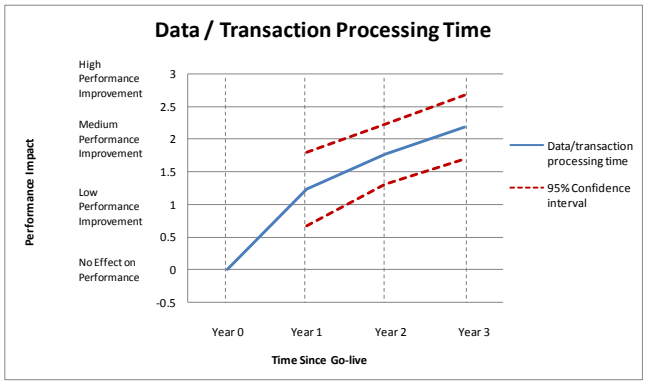
Figure 5.14 Financial benefits PNBF graphs

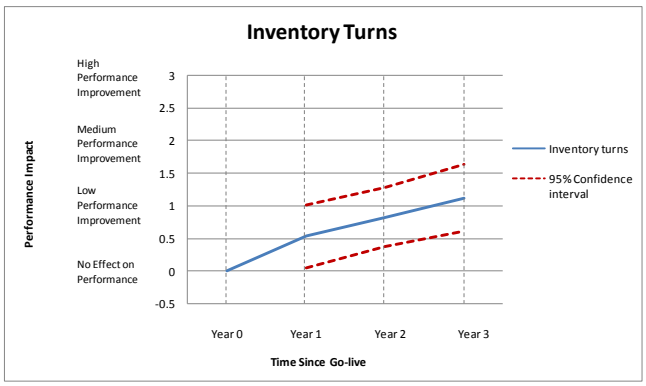
Internal business benefits PNBF graphs:

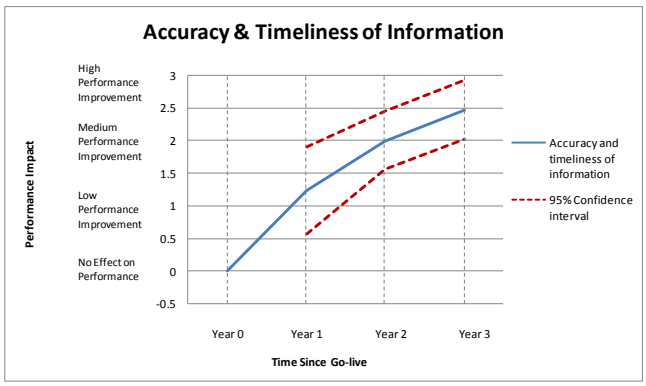


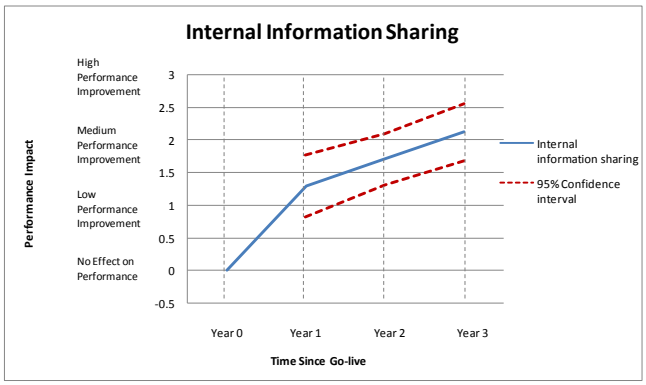












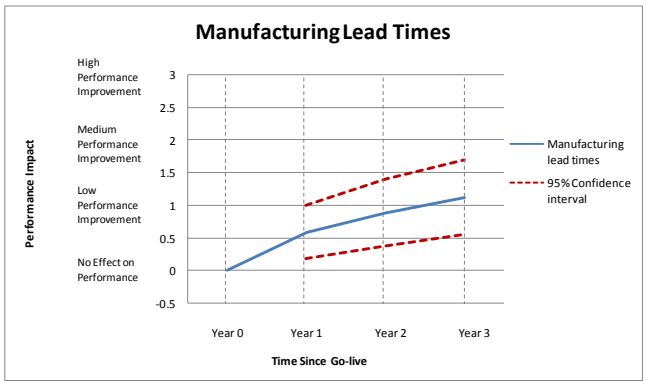
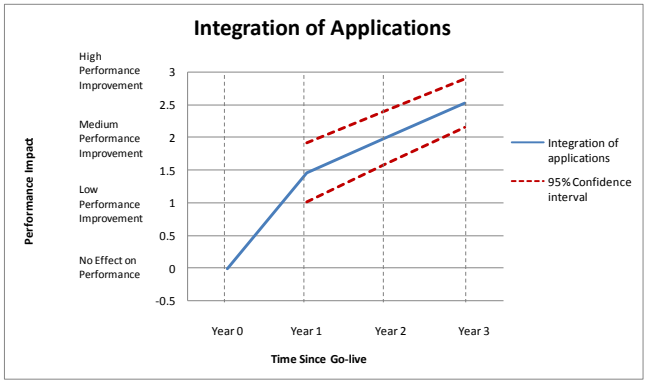
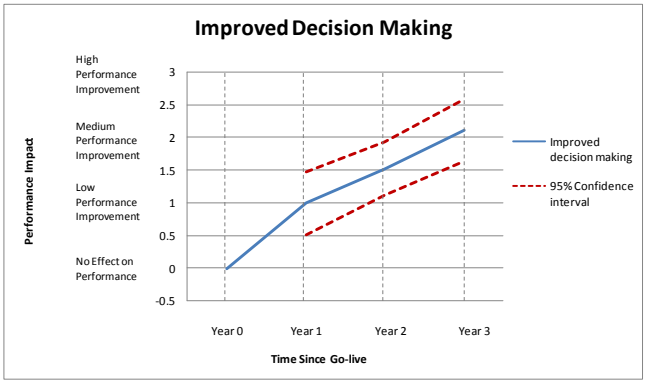


Figure 5.15 Internal business benefits PNBF graphs (part 1)





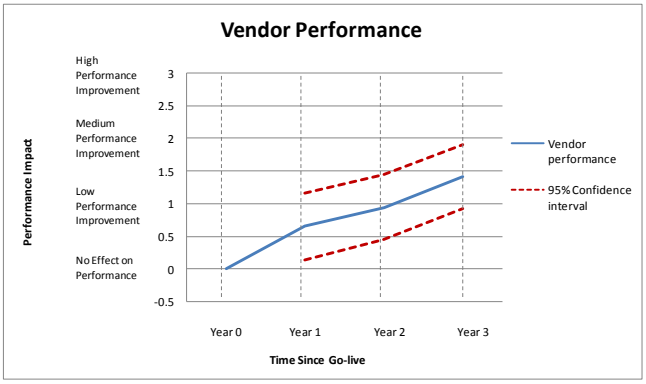
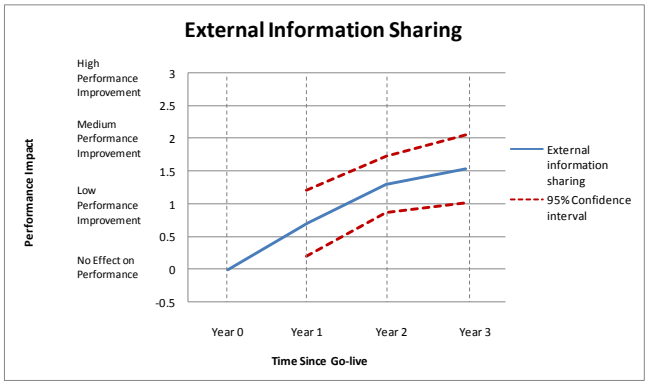


Figure 5.16 Internal business benefits PNBF graphs (part 2)

Customer benefits PNBF graphs:







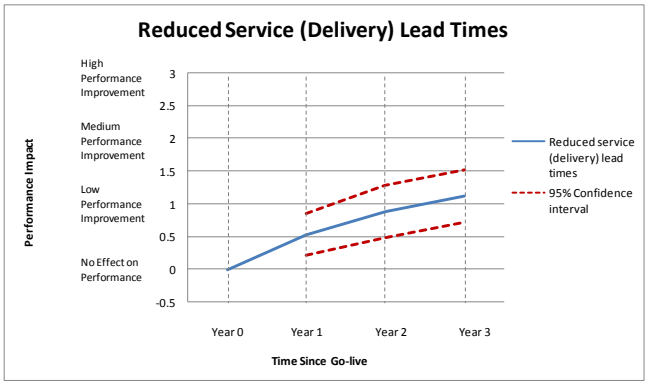


Figure 5.17 Customer benefits PNBF graphs

Learning & growth benefits PNBF graphs:

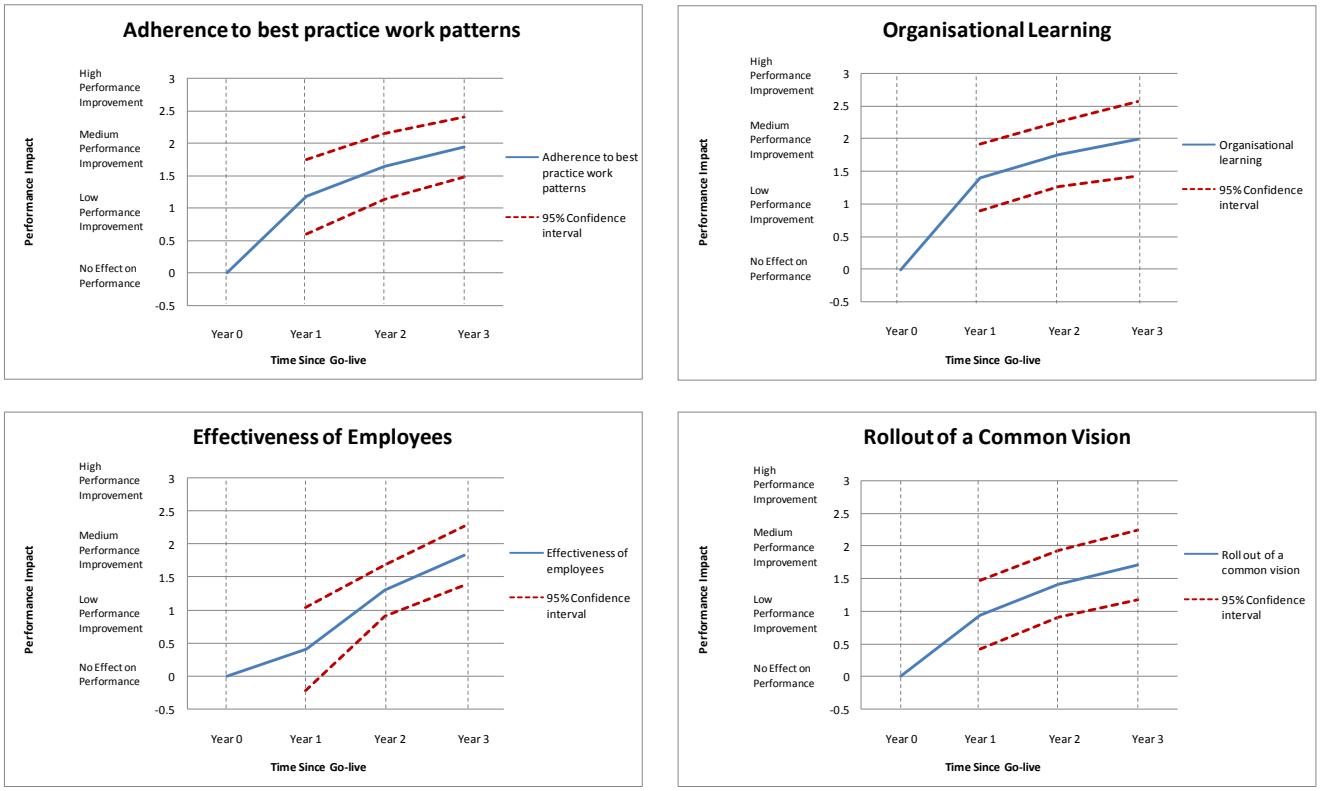


Figure 5.18 Learning & growth PNBF graphs

Analysis of benefits results

Through analysing Table 5.4, Table 5.5 and the resulting graphs the following observations are made:

1. Four of the top five benefits that are realised in "year 1" are Internal Business benefits. From highest to lowest these top five benefits are:
    a. integration of applications (Internal Business);
    b. organisational learning (Learning & Growth);
    c. internal information sharing (Internal Business);
    d. accuracy and timeliness of information (Internal Business); and
    e. data/transaction processing time (Internal Business).

    All these benefits are achieved at a "low-to-medium" extent in "year 1".

2. The five benefits with the lowest performance impact in "year 1" are (from lowest to highest):
    a. IT operating costs (Financial);
    b. turnover/sales (Financial);
    c. manufacturing productivity and efficiency (Internal Business);
    d. stock levels (Financial); and
    e. customer service (Customer).

    Three benefits in this list are financial measures. In fact in the case of "IT operating costs" there is a negative average in "year 1 & 2" indicating an increase in IT operating costs during these periods. This is amplified by a negative lower confidence limit.
3. In "year 1", 19 of the 23 benefit means indicate a positive impact on performance, confirmed via the confidence intervals to be significantly higher than zero.
4. In "year 1", the four benefits that do not show an impact on performance that is significantly higher than zero are:
    a. IT operating costs (Financial);
    b. operating and admin costs (Financial);
    c. effectiveness of employees (Learning and Growth); and
    d. stock levels (Financial).
5. The positive trends of the graphs show that in all cases the benefits identified increase from "year 1" to "year 3".
6. By "year 3", 22 of the 23 benefits show a performance improvement that is significantly higher than zero.
7. "IT operating costs" is the only benefit that does not show an improvement in performance that is significantly higher than zero over the three year period.
8. By "year 3", the five top benefits to be realised are all Internal Business benefits:
    a. integration of applications;
    b. accuracy and timeliness of information;
    c. enhanced business processes;

d. data/transaction processing time; and
e. internal information sharing.

These five benefits all show an improvement at a "medium-to-high" extent.

9. By "year 3", seven benefits show a "medium-to-high" performance improvement, 14 benefits show a "low-to-medium" performance improvement, and two benefits show a "no-to-low" performance improvement.
10. The two benefits to show a "no-to-low" performance improvement over the three year time period are both financial measures:
    a. IT operating costs (discussed under point 7 above); and
    b. turnover/sales.

    "Turnover/sales" is an important measure as it directly impacts Net Profit. However, Net Profit is also directing affected by "operating and admin costs" which shows a "low-to-medium" performance improvement.

Survey results for objective 2

Step 1: Determine the internal consistency reliability of the ERP Time-Based BSC

The computer program, PASW, was used to calculate Cronbach's α and related statistics for the multi-item Likert scales, used in the survey to gather data on the benefits comprising the four perspectives. Table 5.6 shows an example of the item analysis output from PASW for the Internal Business Perspective (in "year 1"). Similar outputs have been generated for each of the four ERP Time-Based BSC perspectives (latent variables) over each of the three time periods. Having generated these outputs, the fifth latent variable (Organisation Performance) is analysed in two ways:

1. The mean values for the four perspectives (taken from Table 5.4 are input to generate an analysis output.
2. All 23 items (benefits) are input into PASW to generate an analysis output.

A complete set of the 18 summary outputs generated via PASW is contained in Appendix H: PASW Analysis Output.

Table 5.6 Sample item analysis output from PASW

Internal Business Perspective (Year 1)

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
10.1176	50.985	7.14040	11

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	.920	.412	1.471	1.059	3.571	.134	11
Item Variances	.938	.493	1.691	1.199	3.433	.120	11
Inter-Item Correlations	.388	-.059	.680	.740	-11.474	.038	11

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Manufacturing_productivity_and_efficiency	9.7059	45.346	.468	.861	.874
Resource_utilization	9.4706	46.265	.443	.945	.875
Enhanced_business_processes	9.0588	40.309	.645	.911	.863
Data_transaction_processing_time	8.8824	41.360	.601	.947	.866
Inventory_turns	9.5882	41.007	.752	.889	.856
Accuracy_and_timeliness_of_information	8.8824	36.485	.815	.825	.848
Internal_information_sharing	8.8235	42.154	.669	.946	.861
Manufacturing_lead_times	9.5294	43.890	.613	.897	.866
Integration_of_applications	8.6471	45.618	.390	.843	.878
Improved_decision_making	9.1176	44.110	.483	.923	.873
Vendor_performance	9.4706	42.640	.565	.685	.868

Cells highlighted where > Cronbach's Alpha

Cells highlighted where < 0.4

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.877	.875	11

Gliem and Gliem (2003) provide a guide for the description of the sections within Table 5.6:

1. Scale Statistics – These are summary statistics for the eleven items comprising the scale.
2. Item Means – These are summary statistics for the eleven individual item means. (It should be noted that these means correspond to the average benefits calculated on Table 5.4.)
3. Item Variances – These are summary statistics for the eleven individual item variances.
4. Inter-Item Correlations – This is descriptive information about the correlation of each item with the sum of all remaining items. Looking at the example in Table 5.6, eleven correlations have been calculated: the correlation between the first item and the sum of the other eleven items, the correlation between the second item and the sum of the other eleven items, etc. The first number listed is the mean of these eleven correlations (0.388), the second number is the lowest of the eleven (-0.059), and so forth.
5. Item-Total Statistics – This is the primary section of the output that is analysed with respect to the internal consistency of the ERP Time-Based BSC. The items in this section are:
    a. Scale Mean if Item Deleted – Excluding the individual item listed, all other scale items are summed and the mean of the summated items is given. In Table 5.6, the mean of the summated scores excluding "manufacturing productivity & efficiency" is 9.7.
    b. Scale Variance if Item Deleted – Excluding the individual item listed, all other scale items are summed and the variance of the summated items is given. In Table 5.6, the mean of the summated scores excluding "manufacturing productivity & efficiency" is 45.3.
    c. Corrected Item-Total Correlation – This is the correlation of the item designated with the summated score for all other items. In Table 5.6, the correlation between "manufacturing productivity &

efficiency" and the summated score is 0.468. A rule-of-thumb is that these values should be at least 0.40 (Gliem & Gliem, 2003, p86). Where values drop below 0.40 the output cells have been highlighted to aid the discussion of the results.

d. Squared Multiple Correlation – This is the predicted Multiple Correlation Coefficient squared, obtained by regressing the identified individual item on all the remaining items. In Table 5.6, the predicted Squared Multiple Regression Correlation is 0.861 by regressing "manufacturing productivity & efficiency" on the other ten items.

e. Cronbach's Alpha if Item Deleted – This is the most important column to be looked at for this research. It represents the scale's Cronbach's alpha reliability coefficient for internal consistency if the individual item is removed from the scale. In Table 5.6, the scale's Cronbach's α would be 0.874 if "manufacturing productivity & efficiency" were removed from the scale. This value is then compared to the Cronbach's Alpha value at the bottom of the table to see if one wants to delete the item. To facilitate this decision, wherever deletion of an item results in an increase in Cronbach's Alpha the cell has been highlighted.

6. Reliability Statistics – The items in this section are:

   a. Cronbach's Alpha – The Cronbach's α coefficient of internal consistency. This is the most frequently used Cronbach's α coefficient, and is used in this study to determine how well the set of items measures the latent variables.

   b. Cronbach's Alpha based on Standardised Items – The Cronbach's α coefficient of internal consistency when all scale items have been standardised. This coefficient is used only when the individual scale items are not scaled the same. (Not applicable to this study.)

Summary of results

The Cronbach's Alpha results from the 18 PASW outputs are summarised in Table 5.7. The average for each latent variable has been calculated using the mean value for the three time periods. An "internal consistency reliability rating" is provided using the scale recommended by George & Mallery (2003):
>0.9 – Excellent, >0.8 - Good, >0.7 – Acceptable, >0.6 – Questionable, >0.5 – Poor and <0.5 – unacceptable.

Table 5.7 Internal consistency reliability summary

Latent Variable	Cronbach's Apha				Internal Consistency Rating
	Year 1	Year 2	Year 3	Average	
LV 1: Financial Perspective	0.656	0.861	0.608	0.708	Acceptable
LV 2: Internal Business Perspective	0.877	0.821	0.877	0.858	Good
LV 3: Customer Perspective	0.821	0.664	0.700	0.728	Acceptable
LV 4: Learning and Growth Perspective	0.767	0.861	0.857	0.829	Good
LV 5: Organisational Performance (using LV 1,2,3,4)	0.899	0.859	0.841	0.867	Good
LV 5: Organisational Performance (using individual items)	0.935	0.902	0.919	0.918	Excellent

To enable a more in depth review of the Cronbach's α results, the relevant statistics from the Item-Total Statistics tables (in the PASW outputs) are consolidated in Table 5.8. By analysing primarily "Cronbach's Alpha if Item Deleted" and secondary "Corrected Item-Total Correlation", an assessment is made as to whether removing certain benefits from the ERP Time-Based BSC would improve the internal consistency reliability of the instrument.

Table 5.8 Consolidated item-total statistics

	Year 1		Year 2		Year 3	
	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Financial Perspective (Latent Variable 1)						
Operating_and_administration_costs	.384	.634	.891	.739	.257	.626
Stock_levels	.351	.640	.610	.864	.311	.595
Turnover	.584	.565	.541	.883	.503	.474
IT_operating_costs	.580	.478	.819	.773	.527	.414
Cronbach's Alpha		.656		.861		.608
Internal Business Perspective (Latent Variable 2)						
Manufacturing_productivity_and_efficiency	.468	.874	.504	.805	.535	.871
Resource_utilization	.443	.875	.168	.836	.472	.875
Enhanced_business_processes	.645	.863	.587	.797	.300	.881
Data_transaction_processing_time	.601	.866	.555	.800	.619	.864
Inventory_turns	.752	.856	.602	.795	.656	.862
Accuracy_and_timeliness_of_information	.815	.848	.638	.792	.686	.860
Internal_information_sharing	.669	.861	.628	.795	.757	.856
Manufacturing_lead_times	.613	.866	.374	.818	.682	.860
Integration_of_applications	.390	.878	.257	.825	-.008	.897
Improved_decision_making	.483	.873	.529	.803	.863	.847
Vendor_performance	.565	.868	.592	.796	.822	.850
Cronbach's Alpha		.877		.821		.877
Customer Perspective (Latent Variable 3)						
Customer_service	.619	.786	.607	.473	.538	.601
On_time_shipments	.600	.795	.468	.582	.631	.536
External_information_sharing	.693	.766	.345	.662	.266	.766
Reduced_service_lead_times	.738	.751	.373	.642	.563	.606
Cronbach's Alpha		.821		.664		.700
Learning & Growth Perspective (Latent Variable 4)						
Adherence_to_best_practice_work_patterns	.647	.668	.891	.739	.769	.794
Organisational_learning	.476	.757	.610	.864	.684	.831
Effectiveness_of_employees	.402	.809	.541	.883	.630	.847
Roll_out_of_a_common_vision	.802	.589	.819	.773	.747	.798
Cronbach's Alpha		.767		.861		.857
ERP Time-Based BSC (Latent Variable 5) - using perspective averages						
Financial_Perspective	.835	.847	.768	.794	.579	.849
Internal_Business_Perspective	.870	.840	.686	.835	.788	.766
Customer_Perspective	.809	.862	.699	.825	.840	.730
Learning_and_Growth_Perspective	.644	.932	.719	.828	.570	.850
Cronbach's Alpha		.899		.859		.841
ERP Time-Based BSC (Latent Variable 5) - using individual items						
Operating_and_administration_costs	.454	.935	.150	.908	.336	.921
Stock_levels	.669	.931	.503	.898	.380	.920
Turnover	.631	.932	.629	.896	.467	.917
IT_operating_costs	.707	.930	.627	.895	.516	.918
Manufacturing_productivity_and_efficiency	.394	.935	.503	.898	.686	.913
Resource_utilization	.544	.933	.131	.906	.392	.919
Enhanced_business_processes	.620	.932	.471	.898	.302	.919
Data_transaction_processing_time	.552	.933	.467	.899	.551	.916
Inventory_turns	.722	.930	.556	.897	.577	.915
Accuracy_and_timeliness_of_information	.811	.928	.525	.897	.687	.913
Internal_information_sharing	.668	.931	.518	.898	.684	.914
Manufacturing_lead_times	.548	.933	.369	.901	.622	.914
Integration_of_applications	.415	.935	.306	.902	.201	.921
Improved_decision_making	.630	.931	.752	.893	.842	.910
Vendor_performance	.733	.930	.771	.891	.826	.911
Customer_service	.726	.930	.725	.893	.686	.913
On_time_shipments	.594	.932	.256	.903	.630	.914
External_information_sharing	.718	.930	.593	.896	.581	.915
Reduced_service_lead_times	.705	.932	.341	.901	.503	.917
Adherence_to_best_practice_work_patterns	.502	.934	.688	.893	.610	.915
Organisational_learning	.381	.935	.631	.895	.451	.918
Effectiveness_of_employees	.643	.931	.578	.896	.781	.912
Roll_out_of_a_common_vision	.671	.931	.725	.892	.585	.915
Cronbach's Alpha		.935		.902		.919

Analysis of Cronbach's α results

The following observations are made regarding the internal consistency reliability results:

Financial Perspective (Latent Variable 1)

1. Cronbach's α ranges from "questionable" to "good" over the three time periods. The average alpha rating is "acceptable".
2. For "year 1" and "year 3" where the rating is "questionable", the results show that removing an item from this category would not increase the reliability rating to the next level.
3. In both "year 1" and "year 3" the correlation between each of the first two items and the rest of item set is shown to be weak.

Internal Business Perspective (Latent Variable 2)

1. Cronbach's α is rated as "good" across all three periods, indicating a high degree of internal consistency.
2. Cronbach's α would increase across all three periods if "integration of applications" is removed from the list. This item also shows the least correlation with the rest of the items.

Customer Perspective (Latent Variable 3)

1. Cronbach's α ranges from "questionable" to "good" over the three time periods. The average alpha rating is "acceptable".
2. The results for "year 2" are "questionable", however removing an item would result in a further reduction of Cronbach's α in this period.
3. Removing "external information sharing" from the list would increase Cronbach's α by 6% in "year 3", but would reduce it by a similar amount in "year 1".

Learning & Growth Perspective (Latent Variable 4)

1. Cronbach's α is "good" for "year 2" and "year 3" as well as the average across the three periods.
2. Removing "effectiveness of employees" from the list would increase the rating to "good" across all three time periods.

ERP Time-Based BSC (Latent Variable 5) – using perspective averages

1. Using the average values for the four perspectives shows the internal consistency to be "good" across all three time periods.
2. Removing the Learning & Growth Perspective would result in an increase in internal consistency in "year 1 and 3", but a reduction in "year 2".
3. The correlation between items is "acceptable" in all cases.

ERP Time-Based BSC (Latent Variable 5) – using individual items

1. Analysing the individual benefits to evaluate the internal consistency of the ERP Time-Based BSC results in a rating of "excellent" across all periods.
2. Cronbach's α would be marginally increased by removing "operating and admin costs" and "integration of applications" from the list. Both these items also display a low correlation with the rest of the items in the list.

Survey results for objective 3

Step 1: Consolidate the ERP benefits results into the four quadrants of the ERP Time-Based BSC to determine if the consolidated results differ significantly from zero over the three year post "go-live" period

Table 5.9 is compiled by consolidating the average benefit values shown in Table 5.4. The confidence intervals have been calculated using the Student's t-distribution, as was done with the individual benefits.

Table 5.9 Perspective averages and confidence intervals

Perspective	Mean			Confidence interval (using Student t dist)					
				Year 1		Year 2		Year 3	
	Year 1	Year 2	Year 3 +	Lower	Upper	Lower	Upper	Lower	Upper
Financial Perspective	0.21	0.68	1.22	-0.167	0.579	0.337	1.016	0.783	1.659
Internal Business Perspective	0.92	1.39	1.80	0.586	1.254	1.119	1.661	1.485	2.120
Customer Perspective	0.54	1.12	1.49	0.216	0.873	0.812	1.423	1.120	1.850
Learning and Growth Perspective	0.99	1.53	1.87	0.551	1.420	1.123	1.936	1.441	2.294
Organisation Performance	0.66	1.18	1.59	0.340	0.988	0.898	1.459	1.273	1.915

Step 2: Construct PNBF graphs to display the consolidated effect of the ERP benefit results over the three year time period, and hence gauge the impact on organisational performance

The data from Table 5.9 is used to construct PNBF graphs for each of the four perspectives, as well as overall organisational performance.

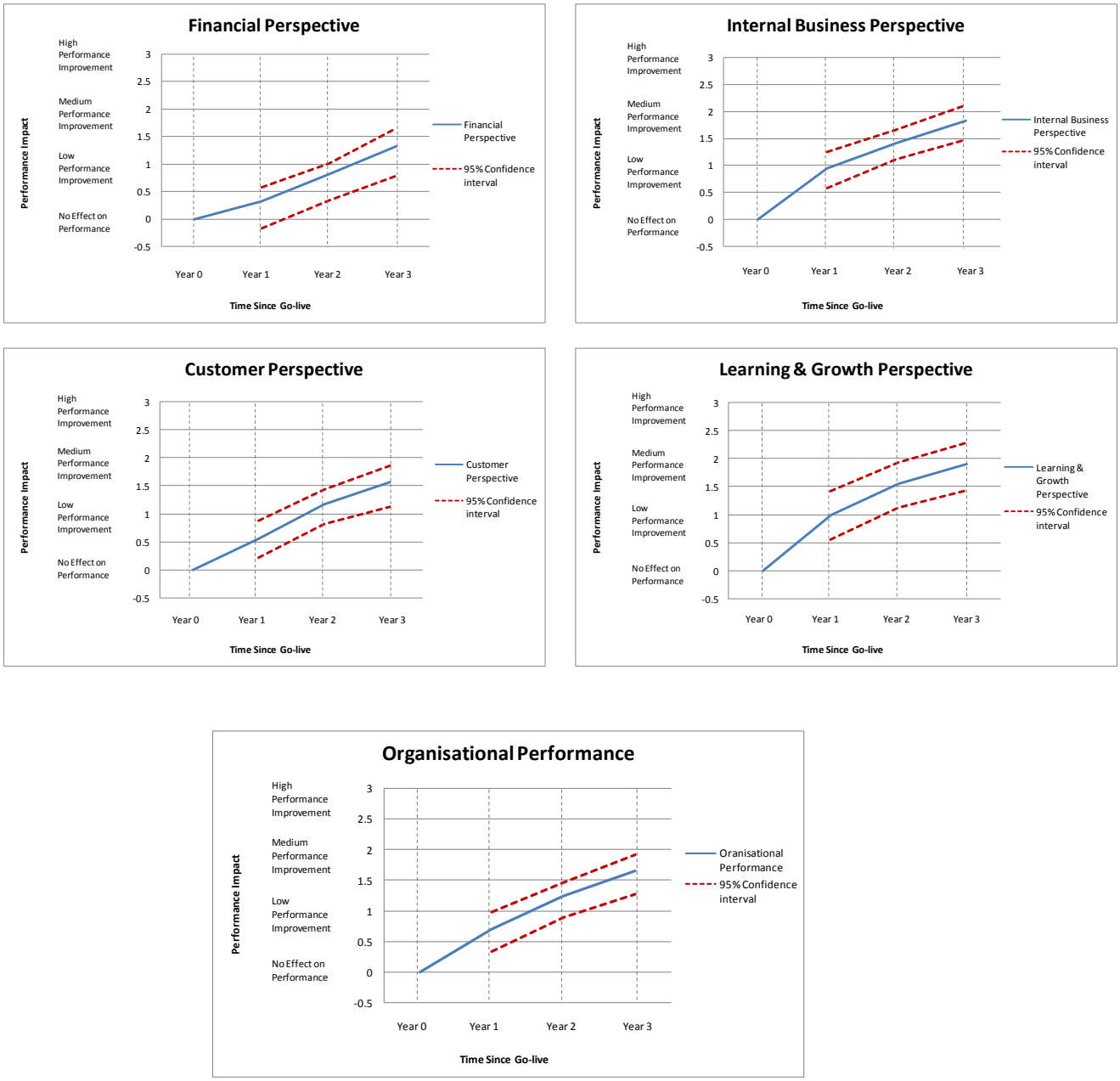


Figure 5.19 ERP Time-Based BSC PNBF graphs

Analysis of organisational performance results

The following observations are made from the results:

Perspective results

1. A slight performance improvement can be noted for all four perspectives in "year 1". However, in the case of the Financial Perspective this increase in performance is not significant.
2. In "year 1", the Learning & Growth Perspective shows the highest level of performance improvement, followed by the Internal Business Perspective, then the Customer Perspective, and lastly the Financial Perspective (showing no significant improvement).
3. Over "year 2" and "year 3" performance improvements increase for all perspectives. In all cases this performance impact can be considered to be significant.
4. The increases in performance are such that the order of improvement levels across the perspectives remains the same as in "year 1" (with the Learning & Growth Perspective showing the highest degree of improvement in "year 2" and "year 3", and the Financial Perspective the least improvement).
5. Although the Financial Perspective shows the least degree of improvement overall, the rate of performance improvement between "year 1" and "year 3" is the greatest of the four perspectives (indicated by the steepest gradient on the PNBF graph during this period).
6. In "year 3", a "low-to-medium" performance improvement is noted for all four perspectives: with the Learning & Growth and Internal Business Perspectives tending towards "medium" and the Financial Perspective tending towards "low".

Overall performance results

1. Performance improvements are significantly above zero for all 3 periods.
2. The slope of the PNBF graph indicates the level of performance improvement increases at roughly a constant rate over the "3 year" period.
3. By "year 3" the results tend towards a "medium" level of performance improvement.

Survey results for objective 4

Step 1: Establish the extent to which CSFs have been in place during the surveyed ERP implementations

Table 5.10 shows the application of the mean, standard deviation and range to the survey data results.

Table 5.10 CSF descriptive statistics

CSF Key:

Extent Adopted	
4	To a great extent
3	Somewhat
2	Very little
1	Not at all

Critical Success Factor	Rank	Company																		Statistics		
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	Mean	Std Dev	Range
Top management commitment	1	4	4	3	4	4	4	4	4	3	3	4	4	4	3	4	4	3	4	3.72	0.46	1
Business planning, vision & strategy	2	1	4	2	3	3	4	3	4	3	3	2	4	4	4	4	4	4	3	3.28	0.89	3
Change management	3	4	2	2	3	4	4	3	4	3	3	4	4	4	4	4	5	2	4	3.50	0.86	3
Education and training	4	4	4	3	4	3	4	4	4	3	3	4	4	3	4	3	5	2	4	3.61	0.70	3
Business process re-engineering	5	4	4	4	4	2	3	3	3	3	3	4	4	3	3	3	4	2	4	3.33	0.69	2
Effective ERP team composition	6	4	3	3	4	3	4	4	4	3	3	4	4	4	4	4	4	2	4	3.61	0.61	2
Project management	7	4	1	2	3	2	2	2	3	2	1	3	4	4	3	3	4	3	3	2.72	0.96	3
Effective communication	8	4	4	4	4	3	4	4	4	3	3	2	4	4	4	4	5	2	4	3.67	0.77	3
Minimum customisation	9	4	3	3	4	4	4	4	4	3	4	2	4	3	3	4	5	3	3	3.56	0.70	3
Software development, testing & troubleshooting	10	4	1	4	4	3	4	4	4	3	3	4	4	4	3	4	4	4	4	3.61	0.78	3

Step 2: Test for an association between CSFs being in place and benefits being achieved

In line with the data assessment methodology: the regression equations, p-values, and R^2 have been calculated for the data set for each time period. Tables 5.11-5.19 show the results of these calculations (per period).

To facilitate analysis of the results, summary tables (Tables 5.20-5.22) have been constructed for each time period where the p-value is less than the required significance level (0.05).

Note: sample calculations for these tables are provided in Appendix G: Sample Calculations.

Results for “year 1”:

Table 5.11 Regression equations – “year 1”

Key:

Gradient	Strength of association
0 to 0.33	weak
0.34 to 0.66	moderate
> 0.67	strong

Note: [ ] denotes the error in the regression equation (the amount of DV variance not explained by the IVs)

	Business planning, vision & strategy	Business process re-engineering	Change management	Education and training	Effective communication
Financial Benefits					
Operating and administration costs	Benefit = 1.15 - 0.18CSF + [1.21]	Benefit = 0.56 - 0.03CSF + [1.22]	Benefit = 1.25 - 0.23CSF + [1.2]	Benefit = 1.22 - 0.21CSF + [1.21]	Benefit = - 0.69 + 0.35CSF + [1.19]
Stock levels	Benefit = - 2.8 + 0.87CSF + [0.79]	Benefit = - 0.3 + 0.22CSF + [0.87]	Benefit = - 0.07 + 0.14CSF + [0.89]	Benefit = - 0.42 + 0.23CSF + [0.88]	Benefit = 0 + 0.13CSF + [0.89]
Turnover/Sales	Benefit = 1.65 - 0.35CSF + [0.6]	Benefit = 0.3 + 0.02CSF + [0.63]	Benefit = 0.3 + 0.01CSF + [0.63]	Benefit = 0.59 - 0.07CSF + [0.62]	Benefit = 0.25 + 0.03CSF + [0.63]
IT operating costs	Benefit = 2.8 - 0.87CSF + [1.3]	Benefit = - 0.43 + 0CSF + [1.37]	Benefit = 0.07 - 0.14CSF + [1.36]	Benefit = 2.63 - 0.85CSF + [1.22]	Benefit = 0 - 0.13CSF + [1.37]
Internal Business Benefits					
Manufacturing productivity and	Benefit = - 0.7 + 0.3CSF + [0.81]	Benefit = - 0.06 + 0.14CSF + [0.81]	Benefit = 0.78 - 0.11CSF + [0.82]	Benefit = 0.46 - 0.01CSF + [0.82]	Benefit = 0.44 - 0.01CSF + [0.82]
Resource utilization (human & machine)	Benefit = 1.45 - 0.22CSF + [0.72]	Benefit = 1.19 - 0.17CSF + [0.71]	Benefit = 0.98 - 0.1CSF + [0.72]	Benefit = 0.86 - 0.06CSF + [0.72]	Benefit = - 0.13 + 0.23CSF + [0.71]
Enhanced business processes	Benefit = - 0.3 + 0.37CSF + [1.17]	Benefit = 0.64 + 0.13CSF + [1.18]	Benefit = 0.63 + 0.13CSF + [1.18]	Benefit = - 1.33 + 0.67CSF + [1.07]	Benefit = - 1 + 0.63CSF + [1.1]
Data/transaction processing time	Benefit = 1.05 + 0.05CSF + [1.13]	Benefit = - 0.18 + 0.43CSF + [1.05]	Benefit = 1.49 - 0.07CSF + [1.13]	Benefit = 0.95 + 0.08CSF + [1.13]	Benefit = 0.44 + 0.24CSF + [1.11]
Inventory turns	Benefit = - 1.2 + 0.47CSF + [0.95]	Benefit = - 0.04 + 0.17CSF + [0.96]	Benefit = 0.31 + 0.06CSF + [0.97]	Benefit = 0.66 - 0.04CSF + [0.97]	Benefit = 0.81 - 0.09CSF + [0.97]
Accuracy and timeliness of information	Benefit = - 3.15 + 1.18CSF + [1.21]	Benefit = 0.79 + 0.13CSF + [1.34]	Benefit = - 1.35 + 0.75CSF + [1.16]	Benefit = - 0.82 + 0.57CSF + [1.28]	Benefit = - 0.88 + 0.64CSF + [1.26]
Internal information sharing	Benefit = - 1.3 + 0.7CSF + [0.89]	Benefit = 0.68 + 0.19CSF + [0.93]	Benefit = 0.54 + 0.22CSF + [0.93]	Benefit = - 0.5 + 0.5CSF + [0.88]	Benefit = - 0.69 + 0.6CSF + [0.85]
Manufacturing lead times	Benefit = 0.65 - 0.02CSF + [0.82]	Benefit = - 0.16 + 0.23CSF + [0.79]	Benefit = 0.79 - 0.06CSF + [0.82]	Benefit = 0.98 - 0.11CSF + [0.82]	Benefit = 1 - 0.13CSF + [0.82]
Integration of applications	Benefit = 1.1 + 0.1CSF + [0.9]	Benefit = 0.58 + 0.27CSF + [0.87]	Benefit = 0.55 + 0.26CSF + [0.87]	Benefit = 0.46 + 0.28CSF + [0.88]	Benefit = 0.31 + 0.35CSF + [0.87]
Improved decision making	Benefit = - 0.05 + 0.28CSF + [0.96]	Benefit = 2.22 - 0.37CSF + [0.9]	Benefit = 1 + 0CSF + [0.97]	Benefit = 1.44 - 0.12CSF + [0.96]	Benefit = - 0.31 + 0.4CSF + [0.92]
Vendor performance	Benefit = 2.5 - 0.5CSF + [1]	Benefit = 0.95 - 0.09CSF + [1.03]	Benefit = 0.7 - 0.01CSF + [1.03]	Benefit = 0.86 - 0.06CSF + [1.03]	Benefit = - 0.13 + 0.23CSF + [1.02]
Customer Benefits					
Customer service	Benefit = 1.4 - 0.27CSF + [0.81]	Benefit = - 0.06 + 0.14CSF + [0.81]	Benefit = - 0.07 + 0.14CSF + [0.81]	Benefit = 0.46 - 0.01CSF + [0.82]	Benefit = - 0.44 + 0.26CSF + [0.8]
On time shipments	Benefit = - 0.15 + 0.18CSF + [0.74]	Benefit = 1.42 - 0.27CSF + [0.7]	Benefit = 0.31 + 0.06CSF + [0.74]	Benefit = 0.22 + 0.09CSF + [0.74]	Benefit = - 0.06 + 0.18CSF + [0.73]
External information sharing	Benefit = 1.2 - 0.13CSF + [1.02]	Benefit = 1.57 - 0.26CSF + [0.99]	Benefit = 0.32 + 0.11CSF + [1.01]	Benefit = 0.73 - 0.01CSF + [1.02]	Benefit = - 0.81 + 0.46CSF + [0.96]
Reduced service (delivery) lead times	Benefit = 0.9 - 0.1CSF + [0.64]	Benefit = 0.69 - 0.05CSF + [0.64]	Benefit = 0.31 + 0.06CSF + [0.64]	Benefit = 0.22 + 0.09CSF + [0.64]	Benefit = - 0.06 + 0.18CSF + [0.63]
Learning and Growth Benefits					
Adherence to best practice work patterns	Benefit = 0.25 + 0.25CSF + [1.16]	Benefit = - 0.56 + 0.53CSF + [1.06]	Benefit = 0.44 + 0.21CSF + [1.15]	Benefit = 0.19 + 0.28CSF + [1.15]	Benefit = 1.13 + 0.02CSF + [1.17]
Organisational learning	Benefit = 1.35 + 0.02CSF + [1.04]	Benefit = 1.43 0CSF + [1.04]	Benefit = 1.21 + 0.06CSF + [1.04]	Benefit = 0.58 + 0.23CSF + [1.02]	Benefit = 0.13 + 0.39CSF + [1]
Effectiveness of employees	Benefit = - 0.7 + 0.3CSF + [1.26]	Benefit = - 0.55 + 0.29CSF + [1.24]	Benefit = - 0.64 + 0.3CSF + [1.24]	Benefit = 0.46 - 0.01CSF + [1.27]	Benefit = - 0.87 + 0.39CSF + [1.24]
Roll out of a common vision	Benefit = 1.25 - 0.08CSF + [1.06]	Benefit = 0.63 + 0.1CSF + [1.06]	Benefit = 0.52 + 0.12CSF + [1.06]	Benefit = 1.57 - 0.17CSF + [1.06]	Benefit = 0.38 + 0.17CSF + [1.06]

	Effective ERP team composition	Minimum customisation	Project management	Software development, testing & troubleshooting	Top management commitment
Financial Benefits					
Operating and administration costs	Benefit = 0.88 - 0.12CSF + [1.22]	Benefit = 0.06 + 0.15CSF + [1.21]	Benefit = 2.01 - 0.42CSF + [1.17]	Benefit = 1.67 - 0.33CSF + [1.19]	Benefit = - 0.34 + 0.23CSF + [1.2]
Stock levels	Benefit = - 1.28 + 0.47CSF + [0.85]	Benefit = 0.23 + 0.07CSF + [0.9]	Benefit = - 0.5 + 0.25CSF + [0.88]	Benefit = - 1.3 + 0.48CSF + [0.83]	Benefit = - 0.97 + 0.38CSF + [0.84]
Turnover/Sales	Benefit = 0.66 - 0.09CSF + [0.62]	Benefit = 0.57 - 0.08CSF + [0.62]	Benefit = - 0.06 + 0.11CSF + [0.62]	Benefit = - 0.3 + 0.18CSF + [0.61]	Benefit = 0.19 + 0.05CSF + [0.63]
IT operating costs	Benefit = 1.28 - 0.47CSF + [1.34]	Benefit = - 0.4 0CSF + [1.37]	Benefit = 0.13 - 0.15CSF + [1.36]	Benefit = - 0.46 + 0.01CSF + [1.37]	Benefit = - 2.23 + 0.51CSF + [1.3]
Internal Business Benefits					
Manufacturing productivity and	Benefit = - 0.11 + 0.14CSF + [0.82]	Benefit = 0.05 + 0.13CSF + [0.81]	Benefit = 0.24 + 0.05CSF + [0.82]	Benefit = - 0.42 + 0.23CSF + [0.8]	Benefit = - 0.61 + 0.28CSF + [0.79]
Resource utilization (human & machine)	Benefit = 0.92 - 0.08CSF + [0.72]	Benefit = 0.61 + 0.02CSF + [0.72]	Benefit = 1.43 - 0.21CSF + [0.7]	Benefit = 1.74 - 0.3CSF + [0.69]	Benefit = - 0.6 + 0.35CSF + [0.67]
Enhanced business processes	Benefit = - 0.94 + 0.56CSF + [1.13]	Benefit = 1.36 - 0.11CSF + [1.18]	Benefit = 0.56 + 0.14CSF + [1.18]	Benefit = 1.32 - 0.07CSF + [1.18]	Benefit = 0.2 + 0.24CSF + [1.17]
Data/transaction processing time	Benefit = 0.86 + 0.11CSF + [1.13]	Benefit = 0.86 + 0.14CSF + [1.12]	Benefit = 1.45 - 0.06CSF + [1.13]	Benefit = 2.72 - 0.41CSF + [1.09]	Benefit = 1.36 - 0.03CSF + [1.13]
Inventory turns	Benefit = 0.12 + 0.12CSF + [0.97]	Benefit = 0.42 + 0.04CSF + [0.97]	Benefit = 1.2 - 0.18CSF + [0.96]	Benefit = - 0.22 + 0.21CSF + [0.96]	Benefit = - 0.78 + 0.37CSF + [0.93]
Accuracy and timeliness of information	Benefit = - 2.66 + 1.09CSF + [1.15]	Benefit = - 0.19 + 0.53CSF + [1.23]	Benefit = 0.35 + 0.24CSF + [1.33]	Benefit = 0.51 + 0.2CSF + [1.33]	Benefit = - 1.48 + 0.76CSF + [1.19]
Internal information sharing	Benefit = - 1.09 + 0.66CSF + [0.85]	Benefit = 0.86 + 0.16CSF + [0.94]	Benefit = 0.27 + 0.28CSF + [0.92]	Benefit = 1.27 + 0.01CSF + [0.95]	Benefit = 1.27 + 0.01CSF + [0.95]
Manufacturing lead times	Benefit = 0.52 + 0.02CSF + [0.82]	Benefit = 0.77 - 0.07CSF + [0.82]	Benefit = 0.76 - 0.05CSF + [0.82]	Benefit = - 0.35 + 0.26CSF + [0.8]	Benefit = - 0.16 + 0.21CSF + [0.8]
Integration of applications	Benefit = 0.12 + 0.38CSF + [0.87]	Benefit = 0.89 + 0.22CSF + [0.88]	Benefit = 0.06 + 0.39CSF + [0.85]	Benefit = 1.34 + 0.04CSF + [0.9]	Benefit = 1.72 - 0.07CSF + [0.9]
Improved decision making	Benefit = - 0.17 + 0.33CSF + [0.94]	Benefit = 0.65 + 0.13CSF + [0.96]	Benefit = 0.63 + 0.1CSF + [0.96]	Benefit = 0.56 + 0.12CSF + [0.96]	Benefit = - 0.77 + 0.49CSF + [0.88]
Vendor performance	Benefit = 0.34 + 0.09CSF + [1.03]	Benefit = 0.61 + 0.02CSF + [1.03]	Benefit = - 0.42 + 0.29CSF + [1]	Benefit = - 0.47 + 0.31CSF + [1]	Benefit = - 1.31 + 0.55CSF + [0.93]
Customer Benefits					
Customer service	Benefit = 0.48 - 0.02CSF + [0.82]	Benefit = 0.05 + 0.13CSF + [0.81]	Benefit = - 0.13 + 0.15CSF + [0.81]	Benefit = - 0.42 + 0.23CSF + [0.8]	Benefit = 0.1 + 0.09CSF + [0.82]
On time shipments	Benefit = 0.12 + 0.12CSF + [0.74]	Benefit = 0.77 - 0.09CSF + [0.74]	Benefit = 0.46 + 0.02CSF + [0.74]	Benefit = - 0.22 + 0.21CSF + [0.72]	Benefit = - 0.43 + 0.27CSF + [0.71]
External information sharing	Benefit = 0.15 + 0.15CSF + [1.01]	Benefit = 0.61 + 0.03CSF + [1.02]	Benefit = 1.36 - 0.18CSF + [1.01]	Benefit = 1.62 - 0.25CSF + [1]	Benefit = - 0.34 + 0.29CSF + [0.99]
Reduced service (delivery) lead times	Benefit = 0.12 + 0.12CSF + [0.64]	Benefit = 0.77 + - 0.09CSF + [0.64]	Benefit = 0.46 + 0.02CSF + [0.64]	Benefit = 0.22 + 0.09CSF + [0.64]	Benefit = - 0.08 + 0.17CSF + [0.63]
Learning and Growth Benefits					
Adherence to best practice work patterns	Benefit = - 1.31 + 0.69CSF + [1.08]	Benefit = 0.85 + 0.12CSF + [1.16]	Benefit = - 1.43 + 0.71CSF + [1.01]	Benefit = - 0.25 + 0.4CSF + [1.13]	Benefit = - 0.68 + 0.52CSF + [1.09]
Organisational learning	Benefit = - 0.87 + 0.63CSF + [0.95]	Benefit = 1.05 + 0.13CSF + [1.03]	Benefit = - 1.35 + 0.76CSF + [0.84]	Benefit = 1.02 + 0.11CSF + [1.03]	Benefit = 0.39 + 0.28CSF + [1.01]
Effectiveness of employees	Benefit = - 1.28 + 0.47CSF + [1.23]	Benefit = - 0.82 + 0.45CSF + [1.18]	Benefit = 0.24 + 0.05CSF + [1.27]	Benefit = 1.79 - 0.38CSF + [1.24]	Benefit = - 0.97 + 0.38CSF + [1.23]
Roll out of a common vision	Benefit = 0.01 + 0.26CSF + [1.05]	Benefit = 0.64 + 0.11CSF + [1.06]	Benefit = - 0.04 + 0.27CSF + [1.04]	Benefit = 1.57 - 0.17CSF + [1.06]	Benefit = - 0.69 + 0.45CSF + [1]

Table 5.12 Significance test (p-value) – "year 1"

Key:

	p-value < 0.05

	Business planning, vision & strategy	Business process re-engineering	Change management	Education and training	Effective communication	Effective ERP team composition	Minimum customisation	Project management	Software development, testing & troubleshootin	Top management commitment
Financial Benefits										
Operating and administration costs	0.784	0.929	0.513	0.627	0.433	0.810	0.632	0.276	0.443	0.552
Stock levels	0.057	0.370	0.590	0.469	0.696	0.190	0.762	0.384	0.119	0.172
Turnover/Sales	0.293	0.908	0.956	0.754	0.897	0.726	0.619	0.585	0.415	0.803
IT operating costs	0.229	1.000	0.724	0.066	0.798	0.398	1.000	0.734	0.984	0.233
Internal Business Benefits										
Manufacturing productivity and	0.496	0.534	0.644	0.973	0.974	0.677	0.537	0.851	0.427	0.276
Resource utilization (Human & machine)	0.573	0.391	0.634	0.816	0.385	0.788	0.915	0.363	0.234	0.115
Enhanced business processes	0.561	0.690	0.704	0.096	0.135	0.238	0.718	0.714	0.868	0.522
Data/transaction processing time	0.935	0.153	0.831	0.842	0.563	0.812	0.629	0.869	0.299	0.934
Inventory turns	0.366	0.525	0.832	0.908	0.803	0.764	0.873	0.565	0.543	0.223
Accuracy and timeliness of information	0.088	0.726	**0.039**	0.222	0.185	**0.033**	0.111	0.578	0.676	0.061
Internal information sharing	0.159	0.465	0.421	0.125	0.071	0.074	0.511	0.355	0.976	0.974
Manufacturing lead times	0.964	0.303	0.801	0.707	0.668	0.953	0.741	0.851	0.368	0.419
Integration of applications	0.838	0.269	0.313	0.378	0.286	0.298	0.338	0.168	0.901	0.808
Improved decision making	0.590	0.151	1.000	0.727	0.253	0.400	0.600	0.748	0.727	0.096
Vendor performance	0.362	0.751	0.973	0.870	0.544	0.831	0.940	0.377	0.392	0.078
Customer Benefits										
Customer service	0.541	0.534	0.555	0.973	0.387	0.953	0.537	0.570	0.427	0.731
On time shipments	0.652	0.174	0.780	0.733	0.509	0.693	0.637	0.933	0.422	0.244
External information sharing	0.813	0.348	0.709	0.978	0.210	0.719	0.909	0.583	0.487	0.366
Reduced service (delivery) lead times	0.774	0.779	0.748	0.695	0.447	0.650	0.587	0.924	0.695	0.404
Learning and Growth Benefits										
Adherence to best practice work patterns	0.692	0.085	0.533	0.499	0.963	0.135	0.690	**0.044**	0.330	0.149
Organisational learning	0.972	1.000	0.842	0.531	0.301	0.123	0.625	**0.012**	0.766	0.392
Effectiveness of employees	0.661	0.402	0.410	0.982	0.401	0.360	0.154	0.903	0.395	0.341
Roll out of a common vision	0.889	0.733	0.697	0.653	0.665	0.549	0.687	0.427	0.653	0.171

Table 5.13 Coefficient of determination (R^2) – "year 1"

Key:

Corresponding value of R^2	Goodness of fit
0 to 0.09	weak
0.09 to 0.49	moderate
0.49 to 1	strong

	Business planning, vision & strategy	Business process re-engineering	Change management	Education and training	Effective communication	Effective ERP team composition	Minimum customisation	Project management	Software development, testing & troubleshootin	Top management commitment
Financial Benefits										
Operating and administration costs	0.005	0.000	0.028	0.016	0.042	0.004	0.016	0.079	0.041	0.023
Stock levels	0.219	0.053	0.020	0.036	0.010	0.112	0.006	0.051	0.153	0.123
Turnover/Sales	0.074	0.001	0.000	0.006	0.001	0.008	0.017	0.021	0.045	0.004
IT operating costs	0.094	0.000	0.008	0.208	0.004	0.048	0.000	0.008	0.000	0.092
Internal Business Benefits										
Manufacturing productivity and	0.031	0.028	0.014	0.000	0.000	0.013	0.027	0.002	0.043	0.081
Resource utilization (Human & machine)	0.021	0.047	0.014	0.003	0.052	0.005	0.000	0.058	0.095	0.156
Enhanced business processes	0.023	0.010	0.009	0.172	0.140	0.091	0.009	0.009	0.002	0.027
Data/transaction processing time	0.000	0.132	0.003	0.003	0.023	0.004	0.016	0.002	0.073	0.001
Inventory turns	0.054	0.029	0.003	0.001	0.004	0.006	0.002	0.024	0.025	0.095
Accuracy and timeliness of information	0.183	0.009	0.251	0.098	0.114	0.267	0.159	0.022	0.012	0.214
Internal information sharing	0.128	0.035	0.042	0.150	0.201	0.199	0.029	0.057	0.000	0.000
Manufacturing lead times	0.000	0.068	0.004	0.009	0.012	0.000	0.007	0.002	0.055	0.044
Integration of applications	0.003	0.080	0.070	0.053	0.076	0.070	0.059	0.121	0.001	0.004
Improved decision making	0.020	0.132	0.000	0.009	0.085	0.047	0.018	0.007	0.009	0.176
Vendor performance	0.056	0.007	0.000	0.002	0.026	0.003	0.000	0.053	0.050	0.190
Customer Benefits										
Customer service	0.025	0.028	0.024	0.000	0.049	0.000	0.027	0.022	0.043	0.008
On time shipments	0.014	0.119	0.006	0.007	0.030	0.010	0.014	0.000	0.044	0.088
External information sharing	0.004	0.059	0.010	0.000	0.103	0.009	0.001	0.020	0.034	0.055
Reduced service (delivery) lead times	0.006	0.005	0.008	0.010	0.039	0.013	0.019	0.001	0.010	0.046
Learning and Growth Benefits										
Adherence to best practice work patterns	0.011	0.183	0.027	0.030	0.000	0.143	0.011	0.246	0.063	0.132
Organisational learning	0.000	0.000	0.003	0.027	0.071	0.153	0.017	0.350	0.006	0.051
Effectiveness of employees	0.013	0.048	0.047	0.000	0.048	0.056	0.133	0.001	0.050	0.062
Roll out of a common vision	0.001	0.007	0.010	0.014	0.013	0.024	0.011	0.042	0.014	0.123

Results for "year 2":

Table 5.14 Regression equations – "year 2"

Key:

Gradient	Strength of association
0 to 0.33	weak
0.34 to 0.66	moderate
> 0.67	strong

Note: [ ] denotes the error in the regression equation (the amount of DV variance not explained by the IVs)

	Business planning, vision & strategy	Business process re-engineering	Change management	Education and training	Effective communication
Financial Benefits					
Operating and administration costs	Benefit = 3.65 - 0.68CSF + [1.1]	Benefit = 2.48 - 0.41CSF + [1.08]	Benefit = 1.67 - 0.16CSF + [1.14]	Benefit = 1.64 - 0.14CSF + [1.14]	Benefit = - 0.38 + 0.45CSF + [1.1]
Stock levels	Benefit = - 0.55 + 0.45CSF + [1.07]	Benefit = 0.29 + 0.25CSF + [1.06]	Benefit = 1.38 - 0.08CSF + [1.09]	Benefit = 1.2 - 0.02CSF + [1.09]	Benefit = 2.25 - 0.34CSF + [1.06]
Turnover/Sales	Benefit = 0.9 - 0.1CSF + [0.74]	Benefit = 0.2 + 0.1CSF + [0.73]	Benefit = 0.31 + 0.06CSF + [0.74]	Benefit = 0.66 - 0.04CSF + [0.74]	Benefit = 0.81 - 0.09CSF + [0.74]
IT operating costs	Benefit = 3.4 - 0.93CSF + [1.26]	Benefit = - 0.62 + 0.17CSF + [1.33]	Benefit = 1.23 - 0.37CSF + [1.3]	Benefit = 3.22 - 0.91CSF + [1.16]	Benefit = 0.69 - 0.23CSF + [1.33]
Internal Business Benefits					
Manufacturing productivity and	Benefit = 1.25 - 0.08CSF + [0.93]	Benefit = 0.38 + 0.17CSF + [0.91]	Benefit = 1.94 - 0.29CSF + [0.89]	Benefit = 1.12 - 0.05CSF + [0.93]	Benefit = 0.81 + 0.04CSF + [0.93]
Resource utilization (Human & machine)	Benefit = - 1.1 + 0.57CSF + [0.93]	Benefit = 1.73 - 0.22CSF + [0.94]	Benefit = 0.72 + 0.08CSF + [0.96]	Benefit = - 0.77 + 0.49CSF + [0.9]	Benefit = - 0.75 + 0.53CSF + [0.89]
Enhanced business processes	Benefit = 0.1 + 0.43CSF + [0.85]	Benefit = 1.1 + 0.18CSF + [0.86]	Benefit = 0.47 + 0.36CSF + [0.82]	Benefit = - 0.48 + 0.61CSF + [0.75]	Benefit = 1.06 + 0.2CSF + [0.87]
Data/transaction processing time	Benefit = 0.9 + 0.23CSF + [0.93]	Benefit = 1.23 + 0.16CSF + [0.92]	Benefit = 1.51 + 0.07CSF + [0.93]	Benefit = 1.17 + 0.17CSF + [0.92]	Benefit = 0.81 + 0.29CSF + [0.91]
Inventory turns	Benefit = - 0.35 + 0.32CSF + [0.9]	Benefit = - 0.37 + 0.36CSF + [0.84]	Benefit = 1.27 - 0.13CSF + [0.9]	Benefit = 0.49 + 0.09CSF + [0.91]	Benefit = 1.31 - 0.15CSF + [0.91]
Accuracy and timeliness of information	Benefit = - 0.1 + 0.57CSF + [0.85]	Benefit = 1.76 + 0.07CSF + [0.89]	Benefit = 0.3 + 0.49CSF + [0.78]	Benefit = 0.23 + 0.49CSF + [0.82]	Benefit = 0.69 + 0.4CSF + [0.85]
Internal information sharing	Benefit = - 0.95 + 0.72CSF + [0.72]	Benefit = 1.83 - 0.04CSF + [0.8]	Benefit = 1.04 + 0.19CSF + [0.78]	Benefit = - 0.04 + 0.49CSF + [0.71]	Benefit = - 0.25 + 0.59CSF + [0.68]
Manufacturing lead times	Benefit = 1.5 - 0.17CSF + [1.02]	Benefit = 0.01 + 0.27CSF + [0.99]	Benefit = 1.47 - 0.17CSF + [1.01]	Benefit = 2.13 - 0.35CSF + [0.99]	Benefit = 2.81 - 0.59CSF + [0.94]
Integration of applications	Benefit = 2 + 0CSF + [0.82]	Benefit = 0.78 + 0.37CSF + [0.74]	Benefit = 1.15 + 0.25CSF + [0.79]	Benefit = 2 + 0CSF + [0.82]	Benefit = 2 + 0CSF + [0.82]
Improved decision making	Benefit = 0.85 + 0.18CSF + [0.82]	Benefit = 2.17 - 0.2CSF + [0.8]	Benefit = 0.75 + 0.23CSF + [0.8]	Benefit = 0.78 + 0.21CSF + [0.81]	Benefit = 0.5 + 0.31CSF + [0.8]
Vendor performance	Benefit = 2.3 - 0.37CSF + [0.98]	Benefit = 1.11 - 0.05CSF + [1]	Benefit = 1.66 - 0.21CSF + [0.98]	Benefit = 0.68 + 0.07CSF + [1]	Benefit = - 0.06 + 0.3CSF + [0.97]
Customer Benefits					
Customer service	Benefit = 2.1 - 0.23CSF + [0.93]	Benefit = 1.28 - 0.01CSF + [0.93]	Benefit = 0.35 + 0.25CSF + [0.9]	Benefit = 0.07 + 0.33CSF + [0.9]	Benefit = - 0.44 + 0.51CSF + [0.86]
On time shipments	Benefit = 1.8 - 0.2CSF + [0.85]	Benefit = 1.86 - 0.24CSF + [0.82]	Benefit = 0.63 + 0.13CSF + [0.85]	Benefit = 0.88 + 0.05CSF + [0.85]	Benefit = 1.63 - 0.17CSF + [0.85]
External information sharing	Benefit = 0.8 + 0.13CSF + [0.87]	Benefit = 2.38 - 0.33CSF + [0.82]	Benefit = 0.54 + 0.22CSF + [0.85]	Benefit = 0.83 + 0.13CSF + [0.87]	Benefit = 0.19 + 0.34CSF + [0.84]
Reduced service (delivery) lead times	Benefit = 3.6 - 0.73CSF + [0.72]	Benefit = 0.98 - 0.03CSF + [0.81]	Benefit = 1.75 - 0.25CSF + [0.77]	Benefit = 2.13 - 0.35CSF + [0.77]	Benefit = 1.94 - 0.32CSF + [0.77]
Learning and Growth Benefits					
Adherence to best practice work patterns	Benefit = 2.45 - 0.22CSF + [1.02]	Benefit = 0.24 + 0.43CSF + [0.95]	Benefit = 1.13 + 0.15CSF + [1.02]	Benefit = 1.41 + 0.07CSF + [1.03]	Benefit = 0.88 + 0.23CSF + [1.02]
Organisational learning	Benefit = 1.95 - 0.05CSF + [1]	Benefit = 0.99 + 0.23CSF + [0.98]	Benefit = 0.38 + 0.4CSF + [0.93]	Benefit = 0.28 + 0.41CSF + [0.95]	Benefit = 0.81 + 0.29CSF + [0.98]
Effectiveness of employees	Benefit = 1.85 - 0.15CSF + [0.79]	Benefit = 0.68 + 0.19CSF + [0.78]	Benefit = 1.11 + 0.05CSF + [0.8]	Benefit = 1.27 + 0.01CSF + [0.8]	Benefit = 0.19 + 0.34CSF + [0.76]
Roll out of a common vision	Benefit = 2.4 - 0.27CSF + [1.03]	Benefit = 0.94 + 0.14CSF + 1.03	Benefit = 0.93 + 0.14CSF + [1.03]	Benefit = 2.35 - 0.26CSF + [1.02]	Benefit = 1 + 0.13CSF + [1.03]

	Effective ERP team composition	Minimum customisation	Project management	Software development, testing & troubleshooting	Top management commitment
Financial Benefits					
Operating and administration costs	Benefit = 1.81 - 0.19CSF + [1.14]	Benefit = 0.49 + 0.23CSF + [1.12]	Benefit = 2.33 - 0.33CSF + [1.12]	Benefit = 2.08 - 0.27CSF + [1.13]	Benefit = 0.47 + 0.18CSF + [1.14]
Stock levels	Benefit = 0.05 + 0.3CSF + [1.07]	Benefit = 1.54 - 0.16CSF + [1.08]	Benefit = 0.86 + 0.07CSF + [1.09]	Benefit = 0.31 + 0.22CSF + [1.08]	Benefit = 0.83 + 0.08CSF + [1.09]
Turnover/Sales	Benefit = 0.12 + 0.12CSF + [0.74]	Benefit = 0.77 - 0.09CSF + [0.74]	Benefit = - 0.27 + 0.22CSF + [0.72]	Benefit = - 0.22 + 0.21CSF + [0.72]	Benefit = - 0.08 + 0.17CSF + [0.73]
IT operating costs	Benefit = 1.36 - 0.39CSF + [1.32]	Benefit = 0.52 - 0.21CSF + [1.32]	Benefit = 1.18 - 0.34CSF + [1.31]	Benefit = 1.89 - 0.54CSF + [1.28]	Benefit = - 0.98 + 0.26CSF + [1.32]
Internal Business Benefits					
Manufacturing productivity and	Benefit = 1.18 - 0.07CSF + [0.93]	Benefit = 1.17 - 0.08CSF + [0.92]	Benefit = 0.7 + 0.07CSF + [0.93]	Benefit = 0.24 + 0.2CSF + [0.92]	Benefit = 1.09 - 0.04CSF + [0.93]
Resource utilization (Human & machine)	Benefit = - 0.17 + 0.33CSF + [0.94]	Benefit = 1.35 - 0.13CSF + [0.96]	Benefit = 1 + 0CSF + [0.97]	Benefit = 1.44 - 0.12CSF + [0.96]	Benefit = 0.29 + 0.2CSF + [0.95]
Enhanced business processes	Benefit = - 0.61 + 0.64CSF + [0.77]	Benefit = 1.44 + 0.1CSF + [0.87]	Benefit = 0.14 + 0.43CSF + [0.8]	Benefit = 0.41 + 0.36CSF + [0.84]	Benefit = 0.31 + 0.39CSF + [0.82]
Data/transaction processing time	Benefit = 0.38 + 0.38CSF + [0.9]	Benefit = 1.45 + 0.12CSF + [0.93]	Benefit = 1.18 + 0.16CSF + [0.92]	Benefit = 2.49 - 0.2CSF + [0.92]	Benefit = 1.99 - 0.06CSF + [0.93]
Inventory turns	Benefit = 0.38 + 0.13CSF + [0.91]	Benefit = 1.33 - 0.19CSF + [0.89]	Benefit = 0.48 + 0.1CSF + [0.91]	Benefit = - 0.4 + 0.34CSF + [0.88]	Benefit = 0.55 + 0.08CSF + [0.91]
Accuracy and timeliness of information	Benefit = - 1.52 + 0.98CSF + [0.64]	Benefit = 0.95 + 0.39CSF + [0.8]	Benefit = 0.89 + 0.3CSF + [0.86]	Benefit = 2 + 0CSF + [0.89]	Benefit = 0.23 + 0.49CSF + [0.8]
Internal information sharing	Benefit = - 1.19 + 0.81CSF + [0.61]	Benefit = 1.44 + 0.1CSF + [0.79]	Benefit = 0.14 + 0.43CSF + [0.72]	Benefit = 1.29 + 0.12CSF + [0.79]	Benefit = 1.37 + 0.09CSF + [0.79]
Manufacturing lead times	Benefit = 1.95 - 0.3CSF + [1.01]	Benefit = 1.51 - 0.23CSF + [1]	Benefit = 1.88 + - 0.27CSF + [1]	Benefit = - 0.08 + 0.27CSF + [1.01]	Benefit = 0.11 + 0.22CSF + [1.01]
Integration of applications	Benefit = 1.41 + 0.16CSF + [0.81]	Benefit = 1.3 + 0.26CSF + [0.77]	Benefit = 0.89 + 0.3CSF + [0.78]	Benefit = 1.56 + 0.12CSF + [0.81]	Benefit = 2 + 0CSF + [0.82]
Improved decision making	Benefit = - 0.64 + 0.61CSF + [0.73]	Benefit = 1.07 + 0.17CSF + [0.81]	Benefit = 0.36 + 0.32CSF + [0.78]	Benefit = 0.33 + 0.33CSF + [0.79]	Benefit = - 0.14 + 0.47CSF + [0.73]
Vendor performance	Benefit = 0.6 + 0.1CSF + [1]	Benefit = 1.52 - 0.21CSF + [0.97]	Benefit = - 0.4 + 0.37CSF + [0.95]	Benefit = - 0.2 + 0.32CSF + [0.97]	Benefit = - 0.33 + 0.35CSF + [0.95]
Customer Benefits					
Customer service	Benefit = - 0.32 + 0.43CSF + [0.89]	Benefit = 0.51 + 0.27CSF + [0.89]	Benefit = - 0.02 + 0.35CSF + [0.89]	Benefit = 0.51 + 0.2CSF + [0.92]	Benefit = - 0.06 + 0.36CSF + [0.88]
On time shipments	Benefit = 0.23 + 0.23CSF + [0.84]	Benefit = 1.18 - 0.05CSF + [0.85]	Benefit = 0.19 + 0.24CSF + [0.83]	Benefit = - 0.01 + 0.3CSF + [0.83]	Benefit = 0.56 + 0.14CSF + [0.85]
External information sharing	Benefit = - 0.5 + 0.5CSF + [0.82]	Benefit = 1.04 + 0.09CSF + [0.87]	Benefit = 1.38 - 0.02CSF + [0.88]	Benefit = 1.27 + 0.01CSF + [0.88]	Benefit = - 0.15 + 0.4CSF + [0.81]
Reduced service (delivery) lead times	Benefit = 2.54 - 0.46CSF + [0.75]	Benefit = 1.86 - 0.36CSF + [0.72]	Benefit = 1.14 - 0.07CSF + [0.8]	Benefit = 0.36 + 0.14CSF + [0.8]	Benefit = 0.47 + 0.12CSF + [0.8]
Learning and Growth Benefits					
Adherence to best practice work patterns	Benefit = 0.16 + 0.41CSF + [0.99]	Benefit = 1.43 + 0.08CSF + [1.03]	Benefit = - 0.89 + 0.7CSF + [0.86]	Benefit = 0.53 + 0.31CSF + [1]	Benefit = 1.1 + 0.15CSF + [1.02]
Organisational learning	Benefit = - 0.79 + 0.71CSF + [0.89]	Benefit = 1.1 + 0.25CSF + [0.97]	Benefit = - 1.04 + 0.77CSF + [0.78]	Benefit = 0.28 + 0.41CSF + [0.95]	Benefit = 1.28 + 0.13CSF + [1]
Effectiveness of employees	Benefit = 0.67 + 0.17CSF + [0.79]	Benefit = 0.86 + 0.16CSF + [0.78]	Benefit = 1.01 + 0.08CSF + [0.79]	Benefit = 2.15 - 0.24CSF + [0.78]	Benefit = 0.56 + 0.2CSF + [0.78]
Roll out of a common vision	Benefit = 0.31 + 0.31CSF + [1.02]	Benefit = 1.23 + 0.07CSF + [1.03]	Benefit = 0.5 + 0.25CSF + [1.02]	Benefit = 1.46 - 0.01CSF + [1.04]	Benefit = 0.03 + 0.38CSF + [0.99]

Table 5.15 Significance test (p-value) – "year 2"

Key:

	p-value < 0.05

	Business planning, vision & strategy	Business process re-engineering	Change management	Education and training	Effective communication	Effective ERP team composition	Minimum customisation	Project management	Software development, testing & troubleshooting	Top management commitment
Financial Benefits										
Operating and administration costs	0.263	0.182	0.630	0.732	0.280	0.686	0.432	0.367	0.507	0.622
Stock levels	0.440	0.400	0.800	0.959	0.393	0.499	0.567	0.842	0.569	0.818
Turnover/Sales	0.803	0.624	0.780	0.880	0.743	0.693	0.637	0.351	0.422	0.469
IT operating costs	0.186	0.645	0.334	**0.041**	0.642	0.475	0.541	0.428	0.248	0.541
Internal Business Benefits										
Manufacturing productivity and	0.873	0.505	0.273	0.880	0.907	0.854	0.738	0.816	0.544	0.893
Resource utilization (Human & machine)	0.266	0.404	0.775	0.140	0.123	0.400	0.600	1.000	0.727	0.514
Enhanced business processes	0.358	0.453	0.143	**0.036**	0.536	0.059	0.657	0.114	0.238	0.149
Data/transaction processing time	0.648	0.532	0.796	0.608	0.396	0.313	0.617	0.594	0.545	0.840
Inventory turns	0.514	0.138	0.622	0.782	0.656	0.728	0.414	0.734	0.287	0.784
Accuracy and timeliness of information	0.228	0.777	**0.043**	0.108	0.215	**0.002**	0.075	0.290	1.000	0.069
Internal information sharing	0.079	0.856	0.406	0.069	**0.030**	**0.005**	0.625	0.079	0.672	0.723
Manufacturing lead times	0.759	0.333	0.566	0.331	0.105	0.473	0.378	0.410	0.456	0.499
Integration of applications	1.000	0.085	0.283	1.000	1.000	0.632	0.205	0.244	0.679	1.000
Improved decision making	0.686	0.375	0.331	0.472	0.302	0.056	0.420	0.219	0.252	0.059
Vendor performance	0.490	0.856	0.465	0.844	0.411	0.807	0.409	0.241	0.362	0.262
Customer Benefits										
Customer service	0.648	0.969	0.349	0.314	0.125	0.251	0.251	0.235	0.545	0.215
On time shipments	0.664	0.300	0.599	0.870	0.589	0.509	0.820	0.379	0.317	0.606
External information sharing	0.784	0.159	0.382	0.677	0.286	0.151	0.690	0.944	0.975	0.138
Reduced service (delivery) lead times	0.078	0.893	0.277	0.212	0.275	0.151	0.067	0.788	0.625	0.641
Learning and Growth Benefits										
Adherence to best practice work patterns	0.692	0.115	0.615	0.849	0.544	0.324	0.763	**0.022**	0.392	0.647
Organisational learning	0.927	0.400	0.155	0.240	0.430	0.068	0.326	**0.008**	0.240	0.684
Effectiveness of employees	0.728	0.383	0.829	0.972	0.239	0.602	0.432	0.756	0.393	0.427
Roll out of a common vision	0.629	0.624	0.641	0.478	0.735	0.463	0.793	0.451	0.978	0.240

Table 5.16 Coefficient of determination (R^2) – "year 2"

Key:

Corresponding value of R^2	Goodness of fit
0 to 0.09	weak
0.09 to 0.49	moderate
0.49 to 1	strong

	Business planning, vision & strategy	Business process re-engineering	Change management	Education and training	Effective communication	Effective ERP team composition	Minimum customisation	Project management	Software development, testing & troubleshooting	Top management commitment
Financial Benefits										
Operating and administration costs	0.083	0.117	0.016	0.009	0.078	0.011	0.042	0.056	0.030	0.017
Stock levels	0.040	0.048	0.004	0.000	0.050	0.031	0.021	0.003	0.023	0.004
Turnover/Sales	0.004	0.016	0.006	0.001	0.007	0.010	0.014	0.058	0.044	0.035
IT operating costs	0.114	0.014	0.062	0.251	0.014	0.035	0.026	0.042	0.089	0.025
Internal Business Benefits										
Manufacturing productivity and	0.002	0.030	0.079	0.002	0.001	0.002	0.008	0.003	0.024	0.001
Resource utilization (Human & machine)	0.081	0.048	0.006	0.141	0.152	0.047	0.018	0.000	0.009	0.028
Enhanced business processes	0.057	0.039	0.134	0.261	0.025	0.220	0.013	0.157	0.092	0.133
Data/transaction processing time	0.015	0.027	0.005	0.017	0.048	0.069	0.016	0.020	0.026	0.003
Inventory turns	0.028	0.141	0.017	0.006	0.013	0.008	0.043	0.007	0.076	0.005
Accuracy and timeliness of information	0.094	0.006	0.245	0.164	0.100	0.490	0.193	0.076	0.000	0.206
Internal information sharing	0.190	0.002	0.047	0.201	0.279	0.419	0.016	0.190	0.011	0.009
Manufacturing lead times	0.006	0.060	0.022	0.062	0.164	0.034	0.053	0.047	0.037	0.030
Integration of applications	0.000	0.185	0.074	0.000	0.000	0.016	0.103	0.091	0.012	0.000
Improved decision making	0.012	0.051	0.061	0.035	0.072	0.219	0.044	0.100	0.088	0.214
Vendor performance	0.032	0.002	0.035	0.003	0.047	0.004	0.047	0.090	0.055	0.085
Customer Benefits										
Customer service	0.015	0.000	0.061	0.066	0.149	0.088	0.086	0.090	0.026	0.101
On time shipments	0.013	0.073	0.017	0.002	0.020	0.030	0.003	0.051	0.065	0.018
External information sharing	0.005	0.128	0.050	0.012	0.074	0.133	0.012	0.000	0.000	0.141
Reduced service (delivery) lead times	0.194	0.001	0.078	0.101	0.079	0.133	0.206	0.005	0.017	0.014
Learning and Growth Benefits										
Adherence to best practice work patterns	0.010	0.155	0.017	0.002	0.026	0.066	0.006	0.302	0.050	0.015
Organisational learning	0.001	0.050	0.129	0.092	0.042	0.206	0.063	0.387	0.092	0.012
Effectiveness of employees	0.008	0.050	0.004	0.000	0.089	0.019	0.041	0.006	0.049	0.044
Roll out of a common vision	0.016	0.017	0.015	0.034	0.007	0.036	0.004	0.038	0.000	0.092

Results for "year 3":

Table 5.17 Regression equations – "year 3"

Key:

Gradient	Strength of association
0 to 0.33	weak
0.34 to 0.66	moderate
0.67 to 1	strong

Note: [ ] denotes the error in the regression equation (the amount of DV variance not explained by the IVs)

	Business planning, vision & strategy	Business process re-engineering	Change management	Education and training	Effective communication
Financial Benefits					
Operating and administration costs	Benefit = 3.8 - 0.53CSF + [1.2]	Benefit = 3.83 - 0.59CSF + [1.15]	Benefit = 2.27 - 0.13CSF + [1.22]	Benefit = 1.49 + 0.09CSF + [1.22]	Benefit = 0.13 + 0.52CSF + [1.17]
Stock levels	Benefit = 1.35 + 0.02CSF + [1.32]	Benefit = 0.52 + 0.26CSF + [1.31]	Benefit = 2.35 - 0.27CSF + [1.3]	Benefit = 2.79 - 0.38CSF + [1.29]	Benefit = 4.06 - 0.8CSF + [1.19]
Turnover/Sales	Benefit = 1.25 - 0.08CSF + [1.06]	Benefit = 1.61 - 0.2CSF + [1.05]	Benefit = 0.81 + 0.04CSF + [1.06]	Benefit = 1.57 - 0.17CSF + [1.06]	Benefit = 1.69 - 0.23CSF + [1.05]
IT operating costs	Benefit = 4.35 - 0.98CSF + [1.46]	Benefit = 3.2 - 0.73CSF + [1.44]	Benefit = 1.46 - 0.22CSF + [1.53]	Benefit = 3.83 - 0.87CSF + [1.4]	Benefit = 0.94 - 0.07CSF + [1.54]
Internal Business Benefits					
Manufacturing productivity and	Benefit = 1.05 + 0.05CSF + [1.07]	Benefit = 1.51 - 0.08CSF + [1.06]	Benefit = 1.49 - 0.07CSF + [1.06]	Benefit = 0.95 + 0.08CSF + [1.06]	Benefit = 0.44 + 0.24CSF + [1.05]
Resource utilization (Human & machine)	Benefit = - 0.5 + 0.5CSF + [1]	Benefit = 2.81 - 0.43CSF + [0.98]	Benefit = 1.02 + 0.1CSF + [1.03]	Benefit = - 0.62 + 0.55CSF + [0.95]	Benefit = 0.38 + 0.3CSF + [1.01]
Enhanced business processes	Benefit = 1.25 + 0.25CSF + [0.65]	Benefit = 2.28 - 0.03CSF + [0.66]	Benefit = 1.44 + 0.21CSF + [0.63]	Benefit = 1.19 + 0.28CSF + [0.62]	Benefit = 2.13 + 0.02CSF + [0.66]
Data/transaction processing time	Benefit = 0.2 + 0.53CSF + [0.95]	Benefit = 3.12 - 0.28CSF + [0.96]	Benefit = 1.44 + 0.21CSF + [0.96]	Benefit = 1.19 + 0.28CSF + [0.96]	Benefit = 0.81 + 0.41CSF + [0.94]
Inventory turns	Benefit = - 0.55 + 0.45CSF + [1]	Benefit = 0.2 + 0.27CSF + [1.01]	Benefit = 0.82 + 0.09CSF + [1.02]	Benefit = - 0.13 + 0.35CSF + [0.99]	Benefit = 1.81 - 0.21CSF + [1.01]
Accuracy and timeliness of information	Benefit = 1.05 + 0.38CSF + [0.88]	Benefit = 3.86 - 0.41CSF + [0.85]	Benefit = 0.99 + 0.43CSF + [0.82]	Benefit = 1.01 + 0.41CSF + [0.85]	Benefit = 0.88 + 0.48CSF + [0.84]
Internal information sharing	Benefit = - 0.6 + 0.73CSF + [0.81]	Benefit = 2.46 - 0.1CSF + [0.88]	Benefit = 1.53 + 0.17CSF + [0.87]	Benefit = 0.43 + 0.47CSF + [0.82]	Benefit = 0.19 + 0.59CSF + [0.78]
Manufacturing lead times	Benefit = 0.5 + 0.17CSF + [1.15]	Benefit = 1.46 - 0.1CSF + [1.15]	Benefit = 0.82 + 0.09CSF + [1.15]	Benefit = 0.31 + 0.22CSF + [1.14]	Benefit = 1.38 - 0.08CSF + [1.15]
Integration of applications	Benefit = 3.95 - 0.38CSF + [0.72]	Benefit = 1.14 + 0.41CSF + [0.68]	Benefit = 2.31 + 0.06CSF + [0.74]	Benefit = 3.99 - 0.41CSF + [0.68]	Benefit = 3.69 - 0.35CSF + [0.7]
Improved decision making	Benefit = 2.55 - 0.12CSF + [0.96]	Benefit = 2.88 - 0.22CSF + [0.94]	Benefit = 1.53 + 0.17CSF + [0.95]	Benefit = 0.43 + 0.47CSF + [0.89]	Benefit = 1.06 + 0.32CSF + [0.93]
Vendor performance	Benefit = 1.35 + 0.02CSF + [0.97]	Benefit = 2.62 - 0.36CSF + [0.93]	Benefit = 2.06 - 0.19CSF + [0.96]	Benefit = 0.58 + 0.23CSF + [0.96]	Benefit = 0.13 + 0.39CSF + [0.93]
Customer Benefits					
Customer service	Benefit = 4.05 - 0.62CSF + [1.09]	Benefit = 2.33 - 0.17CSF + [1.12]	Benefit = 1.51 + 0.07CSF + [1.13]	Benefit = 1.17 + 0.17CSF + [1.12]	Benefit = 0.38 + 0.42CSF + [1.09]
On time shipments	Benefit = 4 - 0.67CSF + [0.99]	Benefit = 2.67 - 0.33CSF + [1.01]	Benefit = 1.88 - 0.1CSF + [1.04]	Benefit = 2.1 - 0.16CSF + [1.03]	Benefit = 3.13 - 0.48CSF + [0.98]
External information sharing	Benefit = 1.9 - 0.1CSF + [1.04]	Benefit = 2.25 - 0.21CSF + [1.03]	Benefit = 0.75 + 0.23CSF + [1.02]	Benefit = 1.22 + 0.09CSF + [1.04]	Benefit = 1.38 + 0.05CSF + [1.04]
Reduced service (delivery) lead times	Benefit = 3.65 - 0.68CSF + [0.74]	Benefit = 2.3 - 0.35CSF + [0.77]	Benefit = 1.67 - 0.16CSF + [0.79]	Benefit = 1.64 - 0.14CSF + [0.8]	Benefit = 1.38 - 0.08CSF + [0.8]
Learning and Growth Benefits					
Adherence to best practice work patterns	Benefit = 2.25 - 0.08CSF + [0.93]	Benefit = 1.35 + 0.17CSF + [0.92]	Benefit = 1.52 + 0.12CSF + [0.92]	Benefit = 1.68 + 0.07CSF + [0.93]	Benefit = 0.94 + 0.3CSF + [0.9]
Organisational learning	Benefit = 2 + 0CSF + [1.15]	Benefit = 1.16 + 0.25CSF + [1.14]	Benefit = - 0.55 + 0.74CSF + [0.94]	Benefit = 0.67 + 0.37CSF + [1.12]	Benefit = 1.13 + 0.27CSF + [1.14]
Effectiveness of employees	Benefit = 1.7 + 0.03CSF + [0.91]	Benefit = 2.57 - 0.22CSF + [0.9]	Benefit = 1.42 + 0.12CSF + [0.91]	Benefit = 0.6 + 0.34CSF + [0.88]	Benefit = 0.13 + 0.52CSF + [0.84]
Roll out of a common vision	Benefit = 1.15 + 0.15CSF + [1.08]	Benefit = 2.1 - 0.12CSF + [1.08]	Benefit = 0.75 + 0.27CSF + [1.05]	Benefit = 2.17 - 0.13CSF + [1.08]	Benefit = 0.63 + 0.33CSF + [1.06]

	Effective ERP team composition	Minimum customisation	Project management	Software development, testing & troubleshooting	Top management commitment
Financial Benefits					
Operating and administration costs	Benefit = 1.38 + 0.13CSF + [1.22]	Benefit = 1.26 + 0.21CSF + [1.21]	Benefit = 1.85 - 0.01CSF + [1.22]	Benefit = 2.43 - 0.17CSF + [1.22]	Benefit = 1.55 + 0.08CSF + [1.22]
Stock levels	Benefit = 1.48 - 0.02CSF + [1.32]	Benefit = 2.08 - 0.25CSF + [1.3]	Benefit = 2.35 - 0.26CSF + [1.3]	Benefit = 1.71 - 0.09CSF + [1.32]	Benefit = 1.45 - 0.01CSF + [1.32]
Turnover/Sales	Benefit = 1.18 - 0.07CSF + [1.06]	Benefit = 1.39 - 0.17CSF + [1.05]	Benefit = 0.7 + 0.07CSF + [1.06]	Benefit = 0.29 + 0.19CSF + [1.05]	Benefit = 0.02 + 0.26CSF + [1.04]
IT operating costs	Benefit = 1.33 - 0.17CSF + [1.54]	Benefit = 1.04 - 0.13CSF + [1.53]	Benefit = 2.1 - 0.38CSF + [1.51]	Benefit = 3.43 - 0.77CSF + [1.43]	Benefit = - 0.69 + 0.39CSF + [1.51]
Internal Business Benefits					
Manufacturing productivity and	Benefit = 0.27 + 0.27CSF + [1.05]	Benefit = 1.35 - 0.04CSF + [1.07]	Benefit = 0.35 + 0.24CSF + [1.05]	Benefit = 0.43 + 0.23CSF + [1.05]	Benefit = 1.36 - 0.03CSF + [1.07]
Resource utilization (Human & machine)	Benefit = - 0.68 + 0.57CSF + [0.96]	Benefit = 1.9 - 0.21CSF + [1.01]	Benefit = 0.2 + 0.32CSF + [1]	Benefit = 0.57 + 0.22CSF + [1.02]	Benefit = 0.48 + 0.24CSF + [1.01]
Enhanced business processes	Benefit = 0.87 + 0.37CSF + [0.61]	Benefit = 1.78 + 0.15CSF + [0.64]	Benefit = 1.05 + 0.31CSF + [0.61]	Benefit = 0.71 + 0.41CSF + [0.58]	Benefit = 0.32 + 0.52CSF + [0.5]
Data/transaction processing time	Benefit = - 0.31 + 0.69CSF + [0.88]	Benefit = 2.17 + 0CSF + [0.98]	Benefit = 0.68 + 0.41CSF + [0.92]	Benefit = 2.43 - 0.07CSF + [0.98]	Benefit = 2.09 + 0.02CSF + [0.98]
Inventory turns	Benefit = - 0.54 + 0.46CSF + [0.98]	Benefit = 1.94 - 0.31CSF + [0.98]	Benefit = 0.12 + 0.27CSF + [1]	Benefit = - 0.57 + 0.48CSF + [0.96]	Benefit = 1.18 - 0.02CSF + [1.03]
Accuracy and timeliness of information	Benefit = - 1.22 + 1.03CSF + [0.62]	Benefit = 2.12 + 0.13CSF + [0.89]	Benefit = 1.06 + 0.39CSF + [0.85]	Benefit = 2.14 + 0.09CSF + [0.9]	Benefit = 0.95 + 0.42CSF + [0.83]
Internal information sharing	Benefit = - 1.3 + 0.95CSF + [0.64]	Benefit = 1.98 + 0.05CSF + [0.88]	Benefit = 0.38 + 0.48CSF + [0.8]	Benefit = 2.14 - 0.01CSF + [0.89]	Benefit = 1.47 + 0.18CSF + [0.87]
Manufacturing lead times	Benefit = - 0.54 + 0.46CSF + [1.11]	Benefit = 1.75 - 0.24CSF + [1.12]	Benefit = 0.49 + 0.17CSF + [1.14]	Benefit = - 0.14 + 0.36CSF + [1.12]	Benefit = 0.47 + 0.18CSF + [1.14]
Integration of applications	Benefit = 3.29 - 0.21CSF + [0.73]	Benefit = 2.31 + 0.08CSF + [0.74]	Benefit = 2.1 + 0.12CSF + [0.73]	Benefit = 2 + 0.15CSF + [0.73]	Benefit = 2.28 + 0.07CSF + [0.74]
Improved decision making	Benefit = - 0.13 + 0.63CSF + [0.87]	Benefit = 2.36 - 0.09CSF + [0.95]	Benefit = 0.01 + 0.58CSF + [0.84]	Benefit = 0.43 + 0.48CSF + [0.89]	Benefit = 1.47 + 0.18CSF + [0.95]
Vendor performance	Benefit = 0.31 + 0.31CSF + [0.95]	Benefit = 1.89 - 0.18CSF + [0.95]	Benefit = - 0.61 + 0.55CSF + [0.86]	Benefit = 0.43 + 0.28CSF + [0.95]	Benefit = 0.74 + 0.19CSF + [0.96]
Customer Benefits					
Customer service	Benefit = 0.38 + 0.38CSF + [1.1]	Benefit = 0.89 + 0.33CSF + [1.08]	Benefit = 0.44 + 0.36CSF + [1.09]	Benefit = 1.29 + 0.14CSF + [1.12]	Benefit = - 0.13 + 0.53CSF + [1.04]
On time shipments	Benefit = 1.7 - 0.05CSF + [1.04]	Benefit = 2.45 - 0.35CSF + [0.99]	Benefit = 1.1 + 0.12CSF + [1.04]	Benefit = 0.57 + 0.27CSF + [1.02]	Benefit = 0.92 + 0.17CSF + [1.03]
External information sharing	Benefit = - 0.64 + 0.61CSF + [0.97]	Benefit = 1.88 - 0.13CSF + [1.03]	Benefit = 1.46 + 0.02CSF + [1.04]	Benefit = 1 + 0.15CSF + [1.03]	Benefit = 0.22 + 0.37CSF + [1]
Reduced service (delivery) lead times	Benefit = 1.81 - 0.19CSF + [0.8]	Benefit = 1.75 - 0.24CSF + [0.77]	Benefit = 0.86 + 0.07CSF + [0.8]	Benefit = 0.71 + 0.11CSF + [0.8]	Benefit = 0.47 + 0.18CSF + [0.79]
Learning and Growth Benefits					
Adherence to best practice work patterns	Benefit = 1.01 + 0.26CSF + [0.91]	Benefit = 2.01 - 0.03CSF + [0.93]	Benefit = - 0.51 + 0.67CSF + [0.75]	Benefit = 0.43 + 0.43CSF + [0.87]	Benefit = 2.44 - 0.14CSF + [0.92]
Organisational learning	Benefit = - 0.93 + 0.82CSF + [1.03]	Benefit = 0.67 + 0.5CSF + [1.05]	Benefit = - 0.58 + 0.71CSF + [1]	Benefit = 0.29 + 0.49CSF + [1.1]	Benefit = 0.23 + 0.49CSF + [1.08]
Effectiveness of employees	Benefit = - 0.38 + 0.62CSF + [0.82]	Benefit = 1.45 + 0.14CSF + [0.9]	Benefit = - 0.37 + 0.6CSF + [0.77]	Benefit = 1.14 + 0.19CSF + [0.9]	Benefit = 0.84 + 0.27CSF + [0.88]
Roll out of a common vision	Benefit = - 0.61 + 0.64CSF + [1]	Benefit = 1.09 + 0.23CSF + [1.06]	Benefit = 0.14 + 0.43CSF + [1.02]	Benefit = 1 + 0.2CSF + [1.07]	Benefit = - 0.4 + 0.59CSF + [0.97]

Table 5.18 Significance test (p-value) – "year 3"

Key:

p-value < 0.05

	Business planning, vision & strategy	Business process re-engineering	Change management	Education and training	Effective communication	Effective ERP team composition	Minimum customisation	Project management	Software development, testing & troubleshootin	Top management commitment
Financial Benefits										
Operating and administration costs	0.418	0.163	0.714	0.837	0.241	0.796	0.527	0.980	0.694	0.838
Stock levels	0.978	0.579	0.478	0.414	0.085	0.971	0.484	0.540	0.847	0.981
Turnover/Sales	0.889	0.596	0.897	0.653	0.557	0.873	0.555	0.839	0.612	0.440
IT operating costs	0.228	0.170	0.622	0.097	0.902	0.788	0.757	0.441	0.143	0.423
Internal Business Benefits										
Manufacturing productivity and	0.931	0.833	0.821	0.833	0.541	0.535	0.891	0.483	0.540	0.930
Resource utilization (Human & machine)	0.362	0.230	0.738	0.118	0.427	0.164	0.450	0.329	0.544	0.461
Enhanced business processes	0.478	0.898	0.261	0.221	0.935	0.157	0.397	0.129	0.061	**0.005**
Data/transaction processing time	0.310	0.420	0.458	0.420	0.249	0.071	1.000	0.183	0.840	0.949
Inventory turns	0.412	0.456	0.762	0.331	0.578	0.265	0.257	0.410	0.173	0.951
Accuracy and timeliness of information	0.432	0.191	0.085	0.191	0.136	**0.001**	0.596	0.168	0.778	0.130
Internal information sharing	0.112	0.751	0.506	0.121	0.056	**0.002**	0.836	0.078	0.975	0.522
Manufacturing lead times	0.784	0.807	0.787	0.589	0.851	0.321	0.439	0.646	0.370	0.622
Integration of applications	0.335	0.106	0.780	0.106	0.189	0.487	0.691	0.615	0.566	0.767
Improved decision making	0.817	0.517	0.539	0.155	0.360	0.094	0.730	**0.045**	0.142	0.554
Vendor performance	0.970	0.290	0.497	0.503	0.268	0.432	0.493	0.063	0.410	0.538
Customer Benefits										
Customer service	0.301	0.672	0.831	0.672	0.306	0.406	0.273	0.315	0.725	0.126
On time shipments	0.222	0.367	0.740	0.666	0.200	0.907	0.205	0.721	0.460	0.608
External information sharing	0.859	0.569	0.443	0.808	0.897	0.139	0.646	0.953	0.683	0.256
Reduced service (delivery) lead times	0.103	0.212	0.492	0.625	0.789	0.564	0.266	0.788	0.700	0.481
Learning and Growth Benefits										
Adherence to best practice work patterns	0.873	0.606	0.656	0.833	0.377	0.492	0.906	**0.013**	0.178	0.636
Organisational learning	1.000	0.542	**0.015**	0.362	0.525	0.068	0.096	**0.042**	0.219	0.170
Effectiveness of employees	0.952	0.496	0.650	0.287	0.108	0.082	0.572	**0.027**	0.554	0.347
Roll out of a common vision	0.797	0.755	0.384	0.736	0.405	0.134	0.430	0.206	0.600	0.071

Table 5.19 Coefficient of determination (R^2) – "year 3"

Key:

Corresponding value of R^2	Goodness of fit
0 to 0.09	weak
0.09 to 0.49	moderate
0.49 to 1	strong

	Business planning, vision & strategy	Business process re-engineering	Change management	Education and training	Effective communication	Effective ERP team composition	Minimum customisation	Project management	Software development, testing & troubleshootin	Top management commitment
Financial Benefits										
Operating and administration costs	0.045	0.124	0.009	0.003	0.089	0.004	0.028	0.000	0.011	0.003
Stock levels	0.000	0.021	0.034	0.046	0.187	0.000	0.034	0.025	0.002	0.000
Turnover/Sales	0.001	0.018	0.001	0.014	0.023	0.002	0.024	0.003	0.017	0.039
IT operating costs	0.096	0.122	0.016	0.173	0.001	0.005	0.006	0.040	0.138	0.043
Internal Business Benefits										
Manufacturing productivity and	0.001	0.003	0.004	0.003	0.026	0.026	0.001	0.035	0.025	0.001
Resource utilization (Human & machine)	0.056	0.093	0.007	0.155	0.042	0.124	0.038	0.062	0.025	0.038
Enhanced business processes	0.034	0.001	0.085	0.095	0.000	0.126	0.047	0.146	0.218	0.419
Data/transaction processing time	0.069	0.043	0.038	0.043	0.089	0.203	0.000	0.115	0.003	0.000
Inventory turns	0.045	0.037	0.006	0.062	0.021	0.083	0.084	0.047	0.120	0.000
Accuracy and timeliness of information	0.042	0.109	0.183	0.109	0.144	0.529	0.020	0.121	0.006	0.149
Internal information sharing	0.161	0.007	0.029	0.153	0.220	0.471	0.003	0.190	0.000	0.028
Manufacturing lead times	0.005	0.004	0.005	0.021	0.002	0.066	0.040	0.015	0.053	0.017
Integration of applications	0.063	0.162	0.006	0.162	0.113	0.033	0.012	0.017	0.023	0.006
Improved decision making	0.003	0.030	0.025	0.131	0.056	0.174	0.009	0.239	0.137	0.024
Vendor performance	0.000	0.072	0.030	0.031	0.081	0.041	0.033	0.215	0.045	0.025
Customer Benefits										
Customer service	0.070	0.012	0.003	0.012	0.070	0.047	0.080	0.068	0.008	0.149
On time shipments	0.097	0.056	0.008	0.013	0.109	0.001	0.103	0.009	0.037	0.018
External information sharing	0.002	0.022	0.038	0.004	0.001	0.138	0.015	0.000	0.011	0.084
Reduced service (delivery) lead times	0.169	0.101	0.032	0.017	0.005	0.023	0.080	0.005	0.011	0.034
Learning and Growth Benefits										
Adherence to best practice work patterns	0.002	0.019	0.014	0.003	0.054	0.032	0.001	0.345	0.117	0.015
Organisational learning	0.000	0.025	0.331	0.055	0.027	0.204	0.176	0.248	0.097	0.124
Effectiveness of employees	0.000	0.031	0.013	0.076	0.161	0.186	0.022	0.286	0.025	0.061
Roll out of a common vision	0.005	0.006	0.052	0.008	0.046	0.145	0.043	0.104	0.019	0.199

Summary tables

Table 5.20 Regression analysis summary table – "year 1"

		Change management	Effective ERP team composition	Project management
Internal Business Benefits				
Accuracy and timeliness of information	p-value	**0.039**	**0.033**	
	Regression equation	Benefit = -1.35 + 0.75CSF + 1.16	Benefit = -2.66 + 1.09CSF + 1.15	
	R^2	0.251	0.267	
Learning and Growth Benefits				
Adherence to best practice work patterns	p-value			**0.044**
	Regression equation			Benefit = -1.43 + 0.71CSF + 1.01
	R^2			0.246
Organisational learning	p-value			**0.012**
	Regression equation			Benefit = -1.35 + 0.76CSF + 0.84
	R^2			0.350

Table 5.21 Regression analysis summary table – "year 2"

		Change management	Education and training	Effective communication	Effective ERP team composition	Project management
Financial Benefits						
IT operating costs	p-value		**0.041**			
	Regression equation		Benefit = 3.22 -0.91CSF + 1.16			
	R^2		0.251			
Internal Business Benefits						
Enhanced business processes	p-value		**0.036**			
	Regression equation		Benefit = -0.48 + 0.61CSF + 0.75			
	R^2		0.261			
Accuracy and timeliness of information	p-value	**0.043**			**0.002**	
	Regression equation	Benefit = 0.3 + 0.49CSF + 0.78			Benefit = -1.52 + 0.98CSF + 0.64	
	R^2	0.245			0.490	
Internal information sharing	p-value			**0.030**	**0.005**	
	Regression equation			Benefit = -0.25 + 0.59CSF + 0.68	Benefit = -1.19 + 0.81CSF + 0.61	
	R^2			0.279	0.419	
Learning and Growth Benefits						
Adherence to best practice work patterns	p-value					**0.022**
	Regression equation					Benefit = -0.89 + 0.7CSF + 0.86
	R^2					0.302
Organisational learning	p-value					**0.008**
	Regression equation					Benefit = -1.04 + 0.77CSF + 0.78
	R^2					0.387

Table 5.22 Regression analysis summary table – "year 3"

		Change management	Effective ERP team composition	Project management	Top management commitment
Internal Business Benefits					
Enhanced business processes	p-value				**0.005**
	Regression equation				Benefit = 0.32 + 0.52CSF + 0.5
	R^2				0.419
Accuracy and timeliness of information	p-value		**0.001**		
	Regression equation		Benefit = -1.22 + 1.03CSF + 0.62		
	R^2		0.529		
Internal information sharing	p-value		**0.002**		
	Regression equation		Benefit = -1.3 + 0.95CSF + 0.64		
	R^2		0.471		
Improved decision making	p-value			**0.045**	
	Regression equation			Benefit = 0.01 + 0.58CSF + 0.84	
	R^2			0.239	
Learning and Growth Benefits					
Adherence to best practice work patterns	p-value			**0.013**	
	Regression equation			Benefit = -0.51 + 0.67CSF + 0.75	
	R^2			0.345	
Organisational learning	p-value	**0.015**		**0.042**	
	Regression equation	Benefit = -0.55 + 0.74CSF + 0.94		Benefit = -0.58 + 0.71CSF + 1	
	R^2	0.331		0.248	
Effectiveness of employees	p-value			**0.027**	
	Regression equation			Benefit = -0.37 + 0.6CSF + 0.77	
	R^2			0.286	

Analysis of CSF results

The following observations are made:

CSF descriptive statistics

1. Mean values for nine of the ten CSFs are between 3 and 4 ("somewhat" to "great extent"). "Project management" is the only exception with a mean of 2.72.
2. The "top management commitment" data results in a standard deviation of 0.46 and a range of 1. This low variation in responses drastically reduces the opportunity to predict a meaningful association between this CSF and the benefits.
3. Seven of the CSFs have a range of 3 and standard deviation between 0.7 and 0.96.
4. Two of the CSFs have a range of 2 and standard deviation of 0.61 and 0.69 respectively.

"Year 1" – regression analysis

1. Four associations can be regarded as being significant.
2. In all four cases the gradient of the regression line indicates a strong positive association.
3. R^2 indicates a moderate degree of fit for all four regression lines.
4. Based on the above three points, the associations that can be described as strongly positive and significant (with a "moderate" level of reliability) are those between:
    a. "change management" & "accuracy and timeliness of information";
    b. "effective ERP team composition" & "accuracy and timeliness of information";
    c. "project management" & "adherence to best practice work patterns"; and
    d. "project management" & "organisational learning".

"Year 2" –regression analysis

1. Eight associations are shown to be significant in "year 2".
2. In four of the eight cases the gradient of the regression line indicates a strong positive association.
3. R^2 indicates a strong degree of fit for one of these regression lines and a moderate degree of fit for the other three.
4. Therefore, the associations that can be described as strongly positive and significant (with a "moderate-to-strong" level of reliability) are those between:
    a. "effective ERP team composition" & "accuracy and timeliness of information";
    b. "effective ERP team composition" & "internal information sharing";
    c. "project management" & "adherence to best practice work patterns"; and
    d. "project management" & "organisational learning".

    Note: an overlap exists regarding three of these associations and the "strongly positive and significant" associations identified in "year 1".

"Year 3" – regression analysis

1. Eight associations are show to be significant in "year 3".
2. In five of the eight cases the gradient of the regression line indicates a strong positive association.
3. R^2 indicates a strong degree of fit for one of these regression lines (same one as in "year 2") and a moderate degree of fit for the other four.
4. In "year 3", the associations that can be described as strongly positive and significant (with a "moderate-to-strong" level of reliability) are those between:
    a. "effective ERP team composition" & "accuracy and timeliness of information";
    b. "effective ERP team composition" & "internal information sharing";

c. "project management" & "adherence to best practice work patterns";
d. "project management" & "organisational learning"; and
e. "change management" & "organisational learning".

Note: the first four associations described above overlap with the "strongly positive and significant" associations identified in "year 2".

5.4 Summary of Market Research Results & Findings

This chapter utilized a survey approach to gather data to analyse the four objectives in greater detail. In total 79 questionnaires were sent out, to approximately 50% of the target population. In total 18 questionnaire responses were received back and although potential sources of bias were identified, all responses were included in the results. The resulting data was analysed according to the steps highlighted in the data assessment methodology (in line with the four research objectives). The main results as they relate to the objectives and corresponding sub-problems are:

Objective 1. Part 1 of Sub-Problem 1 asks:
What are the benefits that manufacturing companies are gaining as a result of implementing ERP systems?
The survey results showed that by the end of "year 1", on average 19 of the 23 benefits were achieved by the surveyed organisations (i.e. showed a performance improvement that is significantly higher than zero). By "year 3", on average 22 of the 23 benefits had been achieved by the sample set.

Part 2 of Sub-Problem 1 asks:
To what extent are benefits being achieved over the three year post "go-live" period?
Analysis of the PNBF graphs indicated that the extent to which benefits are achieved increases over the three year period. In "year 1" the top five benefits are achieved at a "low-to-medium" extent, but by "year 3" the top five benefits are achieved at a "medium-to-high" extent. By "year 3" the extent to which benefits

are achieved ranges from a "no-to-low" performance improvement, to a "medium-to-high" performance improvement, with certain Internal Business benefits being achieved to the greatest extent and certain Financial benefits to the least extent.

Objective 2. The market research enabled the reliability portion of Sub-Problem II to be addressed:

Is the ERP Time-Based BSC a valid and reliable ERP PMS?

The PASW output data surrounding Cronbach's α showed the internal consistency reliability of the ERP Time-Based BSC to be "good-to-excellent" at an overall level. The internal consistency of the four BSC perspectives ranges from "acceptable-to-good".

Objective 3. Consolidating the benefits results into the four perspectives enabled the further investigation of Sub-problem III:

How are ERP benefits impacting on the organisational performance of the company over the three year post "go-live" period?

The results showed that a significant performance improvement was achieved for all perspectives, with the exception of the Financial Perspective, in "year 1". By "year 2" the performance improvement is significant across all four perspectives. The performance impact was noted to increase on a year-by-year basis. Consolidating the results of the four perspectives showed overall organisation performance improvements to be significantly above zero for all three periods. The level of improvement was noted to increase at roughly a constant rate over the three years, resulting in a "medium" performance improvement in "year 3".

Objective 4. Linear regression was used to investigate Sub-Problem IV:

What CSFs can be associated with ERP benefits being achieved?

The results revealed four associations for "year 1" and "year 2", and five associations for "year 3", that can be described as strongly positive and significant (with a "moderate-to-strong" level of reliability). Three of the identified associations overlap all three periods.

6 DISCUSSION OF RESULTS

This chapter begins by discussing the background sources of bias identified through the survey questionnaire responses. The validity of the research method employed is then discussed. Having established the factors impacting on the internal and external validity of the study the chapter then focuses on the research results as they relate to the four objectives. These results are discussed in relation to the literature findings to determine if agreement can be found between the results of this study and previous research.

6.1 Background Sources of Bias

Background sources of potential bias were identified through the demographic and background information collected via the initial sections of the survey questionnaire (results are reviewed in section 5.3.3). This section discusses these sources of bias with emphasis on their potential influence on the research results and conclusions. They are discussed in the same order as section 5.3.3, with the risk of potential bias summarised in Table 6.1:

Table 6.1 Background sources of bias

Background Sources of Bias	Risk of Bias
Respondent's position in the organisation	Low
Organisational reporting level	Medium
Annual revenue	Low
Industry segmentation	Medium
Primary manufacturing process	Low
Enabling systems in place	High
Brand of ERP system	Low
Year of "go-live"	Medium
Number of legacy systems in place	Low
Prior ERP system in place	Low

6.1.1 Respondent's position in the organisation

All the respondents were assessed to be at a suitable level to participate in the study. It was also noted that a sufficient spread of positions has been included so

as not to bias the results towards a particular job function (or profession). Therefore, the potential for bias from this source is assessed to be low.

6.1.2 Organisation reporting level

The results show that 44% of respondents completed the questionnaire for the entire organisation. In 56% of the cases responses are at a divisional or plant level. Although, the responses at the lower levels are deemed to be acceptable for inclusion in the study, they do present a risk in that they may not be representative of the entire organisation. However, due to the senior positions occupied by the respondents the risk of bias is reduced.

6.1.3 Annual revenue

The literature review did not classify organisational size as a critical factor for ERP success. At no stage in the interview process did the respondents suggest that organisational size should be included as a CSF. However, as noted in section 5.3.3, the behaviour of small and large firms, and their ability to implement an ERP system, may differ. As such the potential for bias towards organisations with an annual revenue of greater than R1 billion is noted, although the risk of this bias is low.

6.1.4 Industry segmentation

The results show that 50% of the respondent companies fall into the Consumer Goods sector. As the operations, processes and service demands can differ considerably from the other sectors (for example, Health Care and Technology), there is a potential that the results obtained are biased towards the Consumer Goods sector and are less applicable to the other sectors. Although ERP systems are by enlarge “industry neutral” in design, these internal business processes could affect the benefits obtain. The potential for bias is this case is assessed to be of medium risk.

6.1.5 Primary manufacturing process

No evidence was found in the literature studies to distinguish between the manufacturing process adopted and ERP benefits obtained. The structured interview comments revealed that manufacturing process would be expected to have a greater influence on MES and APS systems than on ERP systems and their benefits. Therefore, despite the high representation of batch production in the results, the risk of bias due to this factor is expected to be minimal (but this classification could add value to future research).

6.1.6 Enabling systems in place

All of the respondent companies have three or more enabling systems in place, with averages tending to a "some-to-moderate" degree of implementation. This is important to note for two reasons:

1. Firstly, the study by Wieder et al (2006) attributes the main performance improvements to enabling systems and not ERP systems.
2. Secondly, the structured interview results revealed that (by enlarge) the interviewees attributed certain benefits primarily to the influence of enabling systems (mainly APS) and only partially to ERP systems.

If survey respondents did not differentiate between the benefits achieved from the different types of systems, inaccuracies could be reflected in the responses. This presents a high potential for bias in the results.

6.1.7 Brand of ERP system implemented

As the main ERP systems are expected to have a feature overlap of 60-70% (Gupta and Kohli, 2004, p3) the potential for bias in the overall results from this factor is expected to be low. However, if bias does exist it is likely due to the high number (50%) of SAP implementations in the responses.

6.1.8 Year of "go-live"

It was found that 94% of the implementations reported on occurred prior to 2006. As ERP technologies have been noted to evolve at a rapid rate (Hendrick et al,

2007) this could affect the applicability of the results to implementations post 2005. On the other end of the scale, 28% of implementations occurred prior to 1996. The potential for bias in this area is perhaps of greater concern due to the respondent's ability to remember accurately the sequence of events and impact on the business that far back. Therefore, there is assessed to be a "medium" potential for bias in the results due to the year of "go-live".

6.1.9 Number of legacy systems in place

The structured interviews revealed "appropriate business & legacy systems management" and "IT infrastructure" to be the least important CSFs on the list (refer to Table 4.6). However, the consolidated interview comments (Table E2) reveal that these same two factors could influence the ability to reduce IT operating costs (especially initially). Therefore, although the overall potential for bias from this factor is considered low, it could affect the IT operating costs in "year 1". In this case the fact that 56% of the respondents had 2-5 legacy systems in place needs to be discussed.

6.1.10 Prior ERP system in place

In line with section 6.1.9, the number of the respondents with previous ERP systems in place could bias the results when analysing IT operating costs (i.e. the IT capital outlay for a company changing over from a previous ERP base would not be expected to be as high as a company moving over from a legacy (or no previous) system.) When discussing this benefit the percentage of respondents transitioning from a previous ERP system (39%) needs to be taken into account.

6.2 Discussion of Methodology Employed

This research was conducted based on the primary question:

Do ERP systems have a positive impact on organisational performance in the years following implementation?

In asking this question a further three secondary questions emerged. These four questions were investigated through the literature review to establish if they have been partially or fully answered by previous research. The literature review provided insight on the studies related to these questions, but was unable to provide a definitive answer to the primary research question. Consequently four objectives were defined to enable this research to explore the research questions in more depth.

Leedy and Ormrod (2005, p97-99) specify that a valid research method needs to be adopted to ensure the accuracy, meaningfulness and credibility of the research project. To ensure that this was achieved a "two phased" approach was adopted for this research:

Phase 1 set out to validate the list of benefits and CSFs, defined through the literature review, by means of a structured interview process. Validation of these lists enabled the content validity of the measurement instrument (ERP Time-Based BSC) to be confirmed, as well as a framework for comparing benefits to CSFs to be established. This phase also enabled a number of factors, which could potentially lead to bias in the market research results (Phase 2), to be identified. By validating the content of the measurement instrument, validating the list of CSFs and identifying potential sources of bias, Phase 1 contributed to the internal validity of the research.

Phase 2 used the results of Phase 1 to conduct a survey to further investigate the four objectives. In line with the recommendations of Gay and Airasian (2003, p113) the survey questionnaire was sent to approximately 50% of the target market. This was done with the aim of increasing the external validity of the

study. However, the external validity of the research results is decreased through a number of sources of potential bias, namely:

1. The responses received cannot be claimed to be entirely random as they were selected based on contact lists supplied from limited sources. Added to this 83% of the responses were received from companies where a relationship could be leveraged.
2. The relatively low response rate, together with the high overall ERP success of the respondent firms, could indicate that those companies with failed implementations chose not to reply.
3. Background sources of potential bias within the data set were also noted (discussed in section 6.1), namely: respondent's position; reporting level; organisational size; industry breakdown; manufacturing process; enabling systems in place; brand of ERP system; year of "go-live"; and prior ERP system in place.

The internal validity of the Phase 2 results has been supported by careful selection of descriptive and inferential statistics. However, as the survey response rate was relatively low, this may influence the internal validity of the research.

In conclusion it can be said that despite efforts to ensure the validity of the research through adopting a two phased approach, the results and their applicability to the total population are put under question through:

1. the non-random selection of the sample population;
2. the low response rate; and
3. sources of potential bias within the sample set.

These factors need to be kept in mind when discussing the research findings as they relate to the objectives in the sections that follow.

6.3 Benefits from ERP Systems

Objective 1 set out to determine the benefits that SA manufacturing companies are gaining as the result of implementing ERP systems, and to gauge the level to which the benefits are being achieved. The ERP benefits were investigated through the two parts of Sub-Problem I:

Part 1: What are the benefits that manufacturing companies are gaining as a result of implementing ERP systems?

Part 2: To what extent are benefits being achieved over the three year post "go-live" period?

These questions were investigated in two phases. Having established a list of expected benefits by means of a literature review, Phase 1 used a series of interviews to validate this list and its applicability to the SA environment. Once the list had been validated and reduced to 23 benefits it was tested by means of a survey. The combined results of the research phases are summarised in Table 6.2.

Table 6.2 Consolidated benefits results

Benefit	Perspective	Market Research Mean			Literature Classi-fication	Interview Classi-fication	Strategy Link
		Year 1	Year 2	Year 3			
Medium to High Performance Improvement							
Integration of applications	Internal Business	1.47	2.00	2.53	A	A	INT
Accuracy and timeliness of information	Internal Business	1.24	2.00	2.47	A	B	INFO
Enhanced business processes	Internal Business	1.06	1.71	2.18	A	A	BP
Data/transaction processing time	Internal Business	1.24	1.76	2.18	B	B	INT
Internal information sharing	Internal Business	1.29	1.71	2.12	A	A	INT
Improved decision making	Internal Business	1.00	1.53	2.12	A	B	NP
Organisational learning	Learning & Growth	1.41	1.76	2.00	C	B	INFO
Low to Medium Performance Improvement							
Adherence to best practice work patterns	Learning & Growth	1.18	1.65	1.94	C	A	BP
Operating and administration costs	Financial	0.47	1.12	1.82	A	A	NP
Effectiveness of employees	Learning & Growth	0.41	1.29	1.82	C	B	BP
Customer service	Customer	0.41	1.24	1.76	B	B	BP
Roll out of a common vision	Learning & Growth	0.94	1.41	1.71	C	A	INFO
On time shipments	Customer	0.53	1.06	1.53	B	A	BP
External information sharing	Customer	0.71	1.29	1.53	A	B	INFO
Stock levels	Financial	0.41	1.12	1.41	B	B	NP
Vendor performance	Internal Business	0.65	0.94	1.41	C	B	BP
Resource utilization (Human & machine)	Internal Business	0.65	1.00	1.35	C	B	BP
Manufacturing productivity and efficiency	Internal Business	0.41	0.94	1.24	B	A	BP
Inventory turns	Internal Business	0.53	0.82	1.12	C	B	BP
Manufacturing lead times	Internal Business	0.59	0.88	1.12	C	B	BP
Reduced service (delivery) lead times	Customer	0.53	0.88	1.12	C	B	BP
No to Low Performance Improvement							
Turnover/Sales	Financial	0.35	0.53	0.94	B	C	NP
IT operating costs	Financial	-0.41	-0.06	0.71	B	B	NP

Note: cells are highlighted where performance increase is not significantly above zero

6.3.1 Addressing Part 1

By analysing Table 6.2 in conjunction with the results displayed in section 5.3.5, it can be observed that in "year 1", 19 of the 23 benefits are obtained at a level significantly above zero. In "year 2" and "year 3", 22 of the 23 benefits are achieved by the sample set. "IT operating costs" is the only benefit showing no significant performance improvement over the three periods. These results from the market research support the literature and interview findings by confirming that at least 22 business benefits are achievable as the result of ERP systems.

6.3.2 Addressing Part 2

The literature provided limited information on the extent to which benefits can be expected, and hence an "ABC" ranking system was adopted to gauge the level of support for each benefit. The extent to which these benefits are expected to be achieved was then predicted via the interview sessions, and a similar ranking system used to predict the main benefits that are being achieved. Finally these benefits were tested using a survey approach.

Market research results. In analysing the survey results through the PNBF graphs it was observed that the main benefits achieved in "year 1" through to "year 3" are mostly Internal Business benefits. In "year 1" the main benefits are achieved at a "low-to-medium" extent and by "year 3" the main benefits are achieved at a "medium-to-high" extent. (By "year 3", seven benefits had been achieved at a "medium-to-high" extent, 14 benefits at a "low-to-medium" extent, and one benefit at a "low" extent.) The gradients for all PNBF graphs were found to be positive between "year 1" and "year 3", indicating that the extent to which benefits are achieved increases over each time period.

The two benefits graphs that stand out in the results, which are worth discussing in more detail, are the "integration of applications" and the "IT operating costs" PNBF graphs (reproduced in Figure 6.1 and Figure 6.2 respectively).

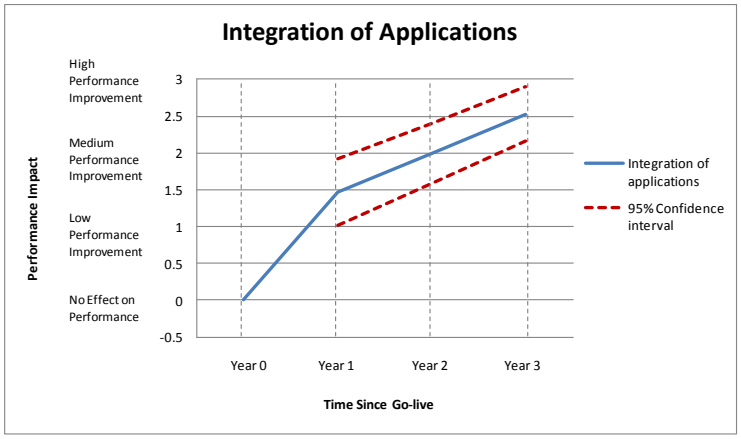


Figure 6.1 Integration of applications

The survey results show "integration of applications" to display the highest benefit over the three time periods, with the gradient indicating the greatest performance improvement in "year 1". This finding corresponds to the literature (section 2.1.2) concerning the main reasons for ERP adoption. Due to the high importance stressed by the literature, this benefit was included as part of the ERP strategy (section 2.2.6). When looking at the comments from the structured interviews (Table E2), the overall comment was made that "integration of applications" is one of the primary benefits that enables other benefits to be achieved. If this is the case it could explain why this benefit appears prominently in period one and other benefits only have a greater impact in the following two periods. It is suggested that this finding be further analysed and developed through the construction of a detailed benefits cause-and-effect tree.

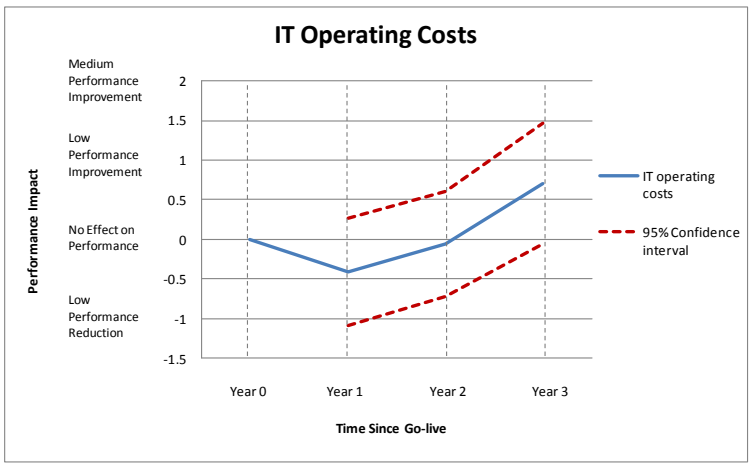


Figure 6.2 IT operating costs

"IT operating costs" (shown in Figure 6.2), is the only identified benefit not to be significantly achieved over all three time periods. This is interesting to note, as both the literature review and structured interviews result in "IT operating costs" being classified as a "B" benefit. However, if the interviewee comments are analysed in more detail (Table E2), the respondents are seen to be divided on this benefit. The general comment is made that an increase in IT costs should be expected initially, and the overall achievement of this benefit depends on the organisation's IT base. The first part of this comment is validated through the average values in Figure 6.2 which show a performance decrease (cost increase) in "year 1". However, when looking at the overall IT base of the sample set, it shows that 56% had 2-5 legacy systems in place, and 39% had previous ERP systems in place. This can be regarded as a fairly high IT base, and yet this benefit is still not achieved to a significant level across the three periods (although the average is seen to increase). This leads to the conclusion that "IT operating costs" should not be viewed as an ERP benefit during the first three years of operation.

Market research and literature comparison. In comparing the overall market research results to the literature findings it can be seen that five of the top seven benefits were ranked as "A" benefits. In this respect a link can be suggested between this study and previous research. However, what is interesting to note is that the literature provided very little evidence of the Learning & Growth benefits being achieved, yet all of them have been achieved tending towards a "medium" extent within the market research results.

Market research and interview comparison. A comparison between the market research results and the interview results reveals that all the "A" and "B" benefits specified through the interviews (with the exception of "IT operating costs") were achieved by the sample set. However, as the "A" and "B" benefits can be seen to be fairly uniformly distributed in Table 6.2 a more detailed correlation between the interview results and the extent to which benefits were achieved in the survey results cannot be proposed. A correlation can however be found between the low

ranking that was given to "turnover/sales" and its position at the bottom of the market research results.

Relating results back to the cause-and-effect tree. In adopting the BSC framework the importance of linking the measures to a common strategy was highlighted. To ensure this within the ERP Time-Based BSC each of the benefits was linked to a component of the strategy, displayed graphically through the cause-and-effect tree in Figure 2.10. This strategic link is again represented in Table 6.2. Interestingly five of the top seven benefits on the list fall under the categories of "enhance information availability" and "integrate applications" (the lower two branches of the cause-and-effect tree). Only one "business process benefit" and one "net profit benefit" appear on this list of "medium-to-high" performance improvement benefits. This could be an indication that the relationship between benefits lower down on the cause-and-effect tree and benefits further up the tree is not directly proportional. Alternatively, it could be an indication that the benefits further up the tree take longer to be fully realised as they are dependent on other benefits first being achieved. However, further research is required to investigate this relationship.

6.4 Validity and Reliability of the ERP Time-Based BSC

Objective 2 aims to establish the validity and reliability of the ERP Time-Based BSC. This objective is investigated through the question proposed by Sub-Problem II:

Is the ERP Time-Based BSC a valid and reliable ERP PMS?

This question was investigated in two phases:

1. Phase 1 aimed to ensure content validity by confirming the list of ERP benefits (established through the literature review) with local ERP experts and business users.
2. Phase 2 aimed to establish the internal consistency reliability (and hence the construct validity) of the ERP Time-Based BSC.

Content validity. The series of ten interviews conducted in Phase 1 enabled a detailed comparison to be made between the benefits identified in the literature and those expected by ERP experts and experienced business users. The fact that no additional benefits were added to the list compiled through the literature indicated that the literature review had enabled a comprehensive list to be established. However, four benefits were removed from the list providing a more focused set of measures. Due to the rigorous process undertaken to confirm the list of benefits it was decided that the resulting list of 23 benefits is a valid list. The validity of the list was further confirmed through investigating Objective 1 where 22 of the 23 benefits were found to have been achieved by the survey sample set. Therefore, with the exception of "IT operating costs", the list of benefits can be considered to be a valid list, and hence the content validity of the ERP Time-Based BSC is confirmed.

Internal consistency reliability. Cronbach's α and related statistics were generated using a statistical software package (PASW) to assess the internal consistency reliability of the ERP Time-Based BSC. This was done by defining the four perspectives as the latent variables and using the individual benefits as the items to be tested. Organisation Performance was then set as the fifth latent variable and was analysed in two ways:

1. Firstly, the mean values of the survey results for the four perspectives were used to generate an analysis output.
2. Secondly, all 23 benefits were input into PASW to generate an analysis output.

Regarding the four perspectives (Latent Variables 1-4) the results showed the internal consistency of the Financial Perspective and the Customer Perspective to range from "questionable" to "good" across the three time periods (with an average of "acceptable"). The average internal consistency of the Internal Business and Learning & Growth Perspectives was found to be "good" (only dropping below this level for the Learning & Growth Perspective in "year 1").

Although the internal consistency of the Financial Perspective and Customer Perspective is "acceptable", Gliem & Gliem (2003, p87) recommend that the goal should be to achieve a rating of "good" ($\alpha > 0.8$). The PASW output was analysed to determine if removing certain benefits from these perspectives would increase the internal consistency to this required level. No items were found to achieve this aim, and it is therefore concluded that although the internal consistency reliability of the four perspectives can be described as ranging from "acceptable" to "good" further research is suggested to verify (and enhance) the internal consistency reliability of the perspectives.

A possible explanation for the varying levels of internal consistency across the four perspectives, could be due to certain items having been assigned to the incorrect perspective. To minimise this risk, the internal consistency of Organisation Performance (Latent Variable 5) was assessed in two ways. By using the mean values of the four perspectives to determine Cronbach's α, the level of internal consistency was shown to be "good" across all three time periods. This internal consistency rating increased to "excellent" when using the individual benefits in the calculation. This discrepancy in internal consistency could indicate that certain benefits have been assigned to the incorrect/sub-optimal perspective. The internal consistency using the individual benefits could be increased slightly by removing "operating and admin costs" and "integration of application" from the list of benefits. However, as these benefits play an important role in establishing the extent to which organisational performance is achieved it would be inadvisable to do so without further research.

Based on assessment of the Cronbach's α values for the five latent variables it is concluded that the internal consistency is sufficiently high for the ERP Time-Based BSC to be considered a reliable instrument for evaluating the impact of ERP systems on organisational performance, within this study. Further, the Cronbach's α values lead to the conclusion that the construct validity of the ERP Time-Based BSC has been established to an acceptable level.

6.5 Impact of ERP Systems on Organisational Performance

Objective 3 aims to address the primary research question by evaluating the impact of ERP systems on organisational performance over time. It does this through addressing Sub-Problem III:

How are ERP benefits impacting on the organisational performance of the company over the three year post "go-live" period?

Having used the survey results to establish the level to which benefits are being achieved, this question was investigated in two steps:

1. Firstly, the ERP benefit results were consolidated into the four perspectives of the ERP Time-Based BSC and the mean values and confidence intervals calculated to determine the performance impact of each perspective across the three time periods.
2. Secondly, PNBF graphs were constructed to graphically display the performance impact over time.

Perspective results. These two steps enabled a number of observations to be made regarding the perspective results and their impact on organisational performance. To summarise, it was found that:

1. A slight performance improvement is achieved for all four perspectives in "year 1" (although in the case of the Financial Perspective this increase is not significant).
2. The performance improvement increases for each perspective over the three time periods.
3. On a year-by-year basis, the Learning & Growth Perspective followed closely by the Internal Business Perspective shows the greatest impact on performance (tending towards a "medium" performance improvement in "year 3"). The Customer Perspective then follows with a "low-to-medium" improvement by "year 3". The Financial Perspective shows the least impact on performance over the three time periods.

Organisational performance results. By applying an equal weighting system to the perspective results, the overall impact on organisational performance was calculated. The results were displayed in a PNBF graph, which is reproduced in Figure 6.3.

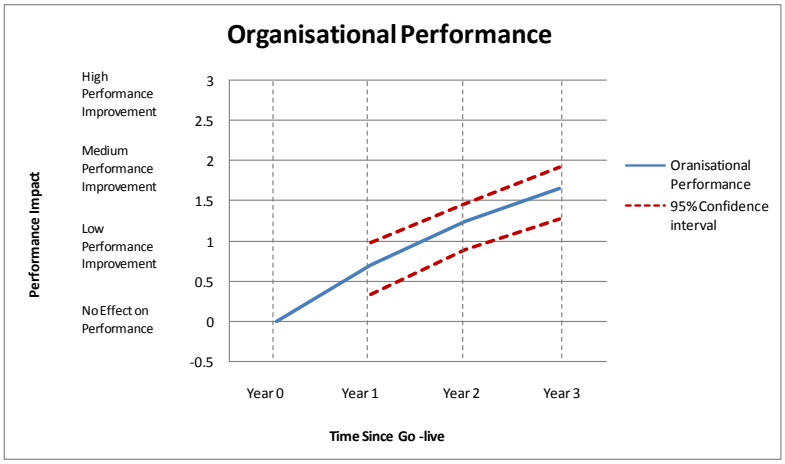


Figure 6.3 Organisational performance impact

Consolidating the results in this manner shows that a significant improvement in organisational performance is achieved by the sample set across all three time periods. This performance impact can be seen to increase at a roughly uniform rate, approaching a "medium" performance improvement in "year 3".

Comparing results to literature findings. In comparing these results to the literature findings a number of observations can be made:

Firstly, a more traditional method of evaluating the impact of ERP systems on organisational performance (as used by Poston and Grabski, 2001; Hunton et al, 2003) would have focused solely on financial measures. If this approach was adopted for this study the conclusion would be drawn that ERP systems have no impact on performance in "year 1" and only a low impact in "year 2" and "year 3".

Secondly, in comparing the results of the market research (showing a "medium" impact on performance) to the results of previous research that also adopts a

balanced measurement approach, further insights can be made. The overall results concur with the findings of Shang and Seddon (2002) and Chand et al (2005), who through a case study approach showed ERP systems to have a positive impact on organisational performance. Although Shang and Seddon (2002) used different perspectives (dimensions) in their scorecard, their PNBF graphs (Figure 2.6) show similar trends to the graphs obtained through this study. The most noticeable difference being the delay in benefit realisation / performance dip across four of Shang and Seddon's (2000) five dimensions: this was only shown to be the case for the Financial Perspective in this study. This indicates that Shang and Seddon's (2000) results are more in line with the initial performance dip of the typical IS progress curve (shown in Figure 2.9), than the results of this study. A possible explanation could be that this performance dip within the SA environment is less than one year and therefore its full severity is not shown in the results. A second explanation could be the potential for bias noted in section 6.1.8, due to the respondents' memories of the initial ERP impact being affected by the year of "go-live". A third explanation could be the interpretation of the Likert scale used in the questionnaire. A "test re-test" approach, as recommended by Leedy and Ormrod (2005, p93), is suggested using recent implementations to investigate these possibilities.

In comparing the results to the broader study conducted by Wieder et al (2006), it is noted that they attributed performance improvements to supply chain management (or enabling) systems instead of the ERP systems. As all of the respondents to the survey indicated the presence of at least three enabling systems in their organisations (discussed in section 6.1.6), there is a chance that the benefits attributed solely to the ERP systems have resulted (at least in part) from the enabling systems. However, as the research is unable to answer this question with the data available, it is suggested that further research be conducted to clarify if the results obtained in this study have been correctly attributed to the ERP systems.

6.6 CSFs for a Successful ERP Implementation

Objective 4 sets out to determine the CSFs required for a successful implementation through their association with ERP benefits being achieved. This objective is investigated through Sub-Problem IV:

What CSFs can be associated with ERP benefits being achieved?

After conducting a literature review to establish a base list of CSFs this sub-problem was investigated in two phases:

1. Phase 1 involved conducting a series of structured interviews to validate the list of CSFs and its applicability to the SA environment.
2. Phase 2 used the survey results to establish the extent to which CSFs were in place in implementing firms. It then conducted a regression analysis to determine if significant associations could be found between CSFs being in place and benefits being achieved.

Despite the literature review providing much information on the CSFs, most of the studies reviewed (for example, Gargeya & Brady, 2005; Umble et al, 2003) concluded with a list of identified factors, but did not associate the factors with specific benefits. Other studies (for example, Al-Mashari et al, 2003) showed a link between CSFs and certain high level benefit areas, but again no direct association was demonstrated with specific benefits. This is important to note as it means that although similarities can be drawn, no direct comparison can be made between the results obtained in this section of the research and previous studies.

Phase 1. Through the structured interviews the literature findings were examined and a validated list of ten ordered CSFs was established (Table 4.6). The ordering of the list is important as logic would suggest that the CSFs regarded as being the most important by the literature and business users/experts would have the greatest impact on the benefits achieved.

Phase 2. The first step in Phase 2 involved determining the level to which CSFs had been in place in the surveyed companies. Perhaps the most important point to note here is that most respondents indicated that “top management commitment”

had been in place to a "great extent" with little variation in the responses. This lack of variation in responses makes it improbable that any meaningful associations can be deduced regarding this CSF.

The second step in Phase 2 involved comparing the CSFs and benefits data, to determine if any significant associations could be established. Regression analysis was used for this purpose:

1. The slope of the regression line was used to indicate the strength of the association.
2. A linear regression t-test was used to determine the significance of the association.
3. The degree to which future outcomes are likely to be predicted by the associations (or the reliability) was established by calculating R^2.

A regression analysis was conducted for each time period as there is the possibility that certain CSFs could lead to benefits being achieved over differing time horizons.

Significant associations. In consolidating the results into summarised tables, a number of associations that can be described as strongly positive and significant (with a "moderate-to-strong" level of reliability) were identified across the time periods:

1. four associations in "year 1";
2. four associations in "year 2"; and
3. five associations in "year 3".

As discussed above, it is possible for different associations to be established over different time periods. However, another aspect to consider in analysing the results is that as 230 significance tests were conducted for each time period there is a possibility that some of the significance levels were the result of chance. To minimise this risk only the associations found to be strongly positive and significant across all three time periods are considered for further discussion.

These associations are those between:

Association 1: "effective ERP team composition" & "accuracy and timeliness of information";

Association 2: "project management" & "adherence to best practice work patterns"; and

Association 3: "project management" & "organisational learning".

Association 1. "Effective ERP team composition" was ranked as only the sixth most important CSF through the structured interviews. However, "accuracy and timeliness of information" was found to be the benefit with the second highest impact on performance. A review of the literature leads to the thinking that this could be a logical association as effective team members would be expected to drive the flow of information as well as ensure its accuracy within the ERP system. If this association is indeed valid, companies should adopt the advice of Siriginidi (2000, p85) by putting more focus on building effective ERP teams to achieve the benefits of accurate and timely information.

Association 2. "Project management" is ranked fairly low (position seven) according to the interviews. "Adherence to best practice work patterns" on the other hand appears fairly high up the list of benefits achieved, showing close to a "medium" performance improvement by "year 3". The literature review highlighted that Umble et al (2003) state that project management must be disciplined in co-ordinating human resource related activities. This association shows these findings of Umble et al (2003) to be valid if the benefit of "adherence to best practice work patterns" is to be achieved.

Association 3. "Organisational learning" has been shown by the market research to be one of the top seven expected ERP benefits. If this association is valid it puts further emphasis on the role of project management in ensuring ERP benefits are realised. It also suggests that the ERP experts and business users should place more emphasis on this CSF.

Summary of association findings. The above findings confirm the case study findings of Motwani et al (2005) and Umble et al (2003) that "effective ERP team composition" and "project management" are critical factors in obtaining ERP benefits. Both these CSFs can be categorised as "people" factors (see Table 4.6 – CSF analysis). This adds support for the general comments made in the structured interviews (Table E5), where the importance of focusing on the "people aspect" of an implementation was repeatedly emphasised.

Despite the support for the three associations, no significant associations were established involving the CSFs ranked in the top half of Table 4.6 (as would have been expected). This finding, together with the point that the associations arise from a relatively small sample set, indicates that further research is required to confirm the validity and reliability of the associations proposed through this research.

6.7 Summary of Discussion of Results

This chapter started off by discussing the background sources of bias. It then analysed the validity of the research method used for this study. It established that a number of precautions were taken in the two phases of the research to ensure the internal and external validity of the study. However, despite these precautions the validity of the results is put under question by the nature and quantity of the survey responses.

The market research results were discussed in relation to the four objectives. Comparisons were made between the survey results and the interview and literature findings. These discussions form the basis for the research conclusions, in Chapter 7.

7 CONCLUSION

This chapter starts off by providing a summary of the research that was undertaken. The research findings are discussed in relation to the objectives, and conclusions are drawn regarding the validity of the hypotheses. After discussing the limitations of the research the chapter closes with a summary of the conclusions.

7.1 Research Overview

After conducting a literary review, the central research problem was defined as:

To determine the impact of ERP systems on organisational performance, by analysing achieved ERP benefits within the framework of a suitable PMS, and to investigate an association between CSFs and ERP benefits.

To fully investigate the research problem four objectives, their related sub-problems and the hypotheses to be tested were defined. To support the validity of the research methodology, and hence encourage meaningful results, a two phased research approach was adopted. Phase 1 used a series of structured interviews to validate the lists of expected benefits and CSFs. This was done to enhance the validity and reliability of the results obtained in Phase 2: the market research. The market research results were analysed and discussed in relation to the literature and interview findings according to the four research objectives. The findings of the discussion are now reviewed in relation to the research hypotheses (in section 7.2) to determine if the objectives of the research have been achieved.

7.2 Hypotheses Testing

This section summarises the findings according to the four objectives to determine the legitimacy of the four hypotheses and establish the extent to which the objectives of the research have been met. It is important to note that these conclusions are drawn in the presence of three main factors that could have affected the validity of the results, namely:

1. the non-random selection of the sample population;
2. the relatively low survey response rate; and
3. sources of potential bias within the sample set.

7.2.1 Objective 1

Objective 1 aims to determine the benefits that SA manufacturing companies are gaining as a result of ERP systems, and to gauge the level to which these benefits are being achieved.

The market research results showed that 22 benefits were achieved by the sample set. Of these benefits achieved seven had been achieved at a "medium-to-high" extent, 14 benefits at a "low-to-medium" extent, and one benefit at a "low" extent. A comparison with the literature reviewed added support to the validity of these results. This was further confirmed by comparing the results to the expectations of the local ERP experts and business users.

Based on these findings it is concluded, on the balance of evidence, that overall South African companies are achieving at least 22 benefits as a result of ERP systems. These benefits are being achieved at varying levels, ranging from a "low" to "high" extent. This conclusion supports *Hypothesis I* and the research therefore states that:

South African manufacturing firms are experiencing business benefits as a result of ERP implementations.

7.2.2 Objective 2

Objective 2 aims to determine the validity and reliability of the ERP Time-Based BSC.

The structured interviews enabled the list of ERP benefits to be validated within the SA environment. Through this validation the content validity of the ERP Time-Based BSC was deduced. The results of the market research were used to evaluate the internal consistency of the ERP Time-Based BSC and its four perspectives. Overall the internal consistency of the scorecard was found to be "good-to-excellent" although it was suggested that further research be conducted to enhance the internal consistency of the four individual perspectives.

Based on these results it is concluded that the ERP Time-Based BSC is sufficiently valid and reliable to draw meaningful conclusions from this study. However, if the ERP Time-Based BSC is to gain further application in industry it is recommended that further research be conducted to confirm its validity and reliability using a larger sample set. Although this conclusion supports *Hypothesis II* an amendment is added to the statement and it is concluded that:
Preliminary research indicates that the ERP Time-Based BSC is a valid and reliable ERP PMS.

7.2.3 Objective 3

Objective 3 aims to evaluate the impact of ERP systems on organisational performance over the three year post "go-live" period.

Consolidating the benefit results of the market research revealed performance improvements across all four perspectives of the ERP Time-Based BSC, with overall Organisational Performance showing a "medium" performance improvement. These findings support the research of Shang and Seddon (2002) and Chand et al (2005). However, comparing the findings to the research of Wieder et al (2006) drew attention to the potential for bias in the results due to the impact of enabling systems being attributed to ERP systems.

Despite the potential for bias in the results due to enabling systems, sufficient evidence has been gathered to show that SA manufacturing companies are achieving organisation performance improvements as a result of the benefits gained from ERP systems. *Hypotheses III* is therefore confirmed and the research states that:

The benefits gained through ERP implementations have a positive impact on organisational performance over the three year post "go-live" period.

7.2.4 Objective 4

Objective 4 aims to determine the CSFs required for a successful implementation through their association with ERP benefits being achieved.

Three strongly positive associations (with a "moderate-to-strong" level of reliability) were identified from the market research results. Similarities were drawn between these associations and some of the literature findings. However, as the associations were established using a relatively small sample set it was recommended that further research be conducted to confirm these associations. It was also noted that the identified associations conflicted in part with the literature and interview results, as they did not include the most supported and highly ranked CSFs.

Considering the above discussion, it is concluded that the research has identified three *possible* associations between CSFs and ERP benefits. However, it is felt that due to the relatively small sample size, as well as the conflict (in part) with the literature and interview findings, there is insufficient evidence to claim these findings as complete and valid. *Hypothesis IV* therefore remains unconfirmed and it is suggested that further research be conducted to validate and build on these findings.

7.3 Study Limitations

This study makes a number of important findings regarding ERP benefits, and CSFs and the degree to which they have been realised within a sample set of South African organisations. It also proposes and demonstrates the use of an ERP performance measurement model. However, there are a number of limitations to this study that should be noted:

The main limitation to the study is the relatively low sample size obtained from the market research. Due to the low sample size conclusive evidence was unable to be obtained surrounding the association between CSFs being in place and performance benefits being achieved. Added to this, the distribution of the data had to be assumed which could have influenced the findings.

Secondly, unlike the studies conducted by Wielder et al (2006) and Hunton et al (2003) this study only measures the performance of organisations who have adopted ERP systems and does not take into account non-adopters to evaluate if the proposed benefits can be achieved over similar time periods by adopting alternate tools or business strategies.

Thirdly, the market research relied mainly on individuals' memories instead of hard facts and company performance data. As people's memories often fade over time, this could have had an impact on the quality of data received.

Lastly, due to the lack of literature relating CSFs to ERP benefits a detailed comparison of the results obtained in this research could not be made to earlier studies. This contributed to Hypothesis IV being unconfirmed and left open for future research.

7.4 Summary of Conclusions

In viewing the sample set in light of the potential sources of bias, the following conclusions are drawn from the results:

Firstly, as ERP benefits have been shown to exist in 22 cases, Hypothesis I was considered to have been adequately confirmed and it was concluded that:
South African manufacturing firms are experiencing business benefits as a result of ERP implementations.

Secondly, the ERP Time-Based BSC was assessed to be sufficiently valid and reliable for this study and it was concluded that:
Preliminary research indicates that the ERP Time-Based BSC is a valid and reliable ERP PMS.

Thirdly, the ERP benefits gained within the sample set were shown to have a positive impact on organisational performance when applied to the ERP Time-Based BSC. It was therefore decided that Hypothesis III is valid:
The benefits gained through ERP implementations have a positive impact on organisational performance over the three year post "go-live" period.

Lastly, although three associations were proposed between CSFs and ERP benefits, there was insufficient evidence to claim these results as complete and valid. Hypothesis IV therefore remains unconfirmed, although a base has been established for further research to be conducted.

In summary, the research was successful in investigating the first three objectives, but was only partially successful in investigating objective 4. The research therefore concludes with the statement that:
Selected SA manufacturing firms are experiencing business benefits as a result of ERP implementations. By using the ERP Time-Based BSC these benefits are shown to have a positive impact on organisational performance. Further research is required to confirm the associations between CSFs and ERP benefits.

The research is summarised in Figure 7.1

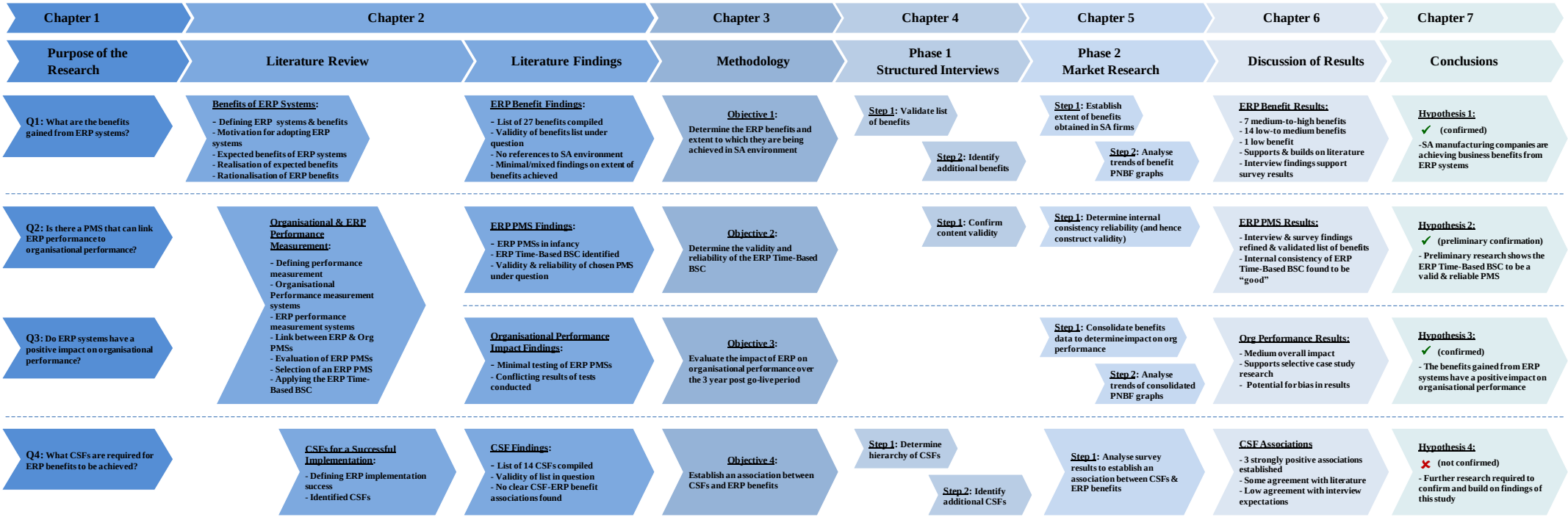


Figure 7.1 Research summary

8 RECOMMENDATIONS FOR FURTHER RESEARCH

Based on the limitations of the research as well as the research findings a number of recommendations for further research are made:

1. It is recommended that further research be conducted to investigate the performance of the total list of manufacturing companies on the Financial Mail's Top 200 list and compare the performance of adopters and non-adopters. This will assist in addressing the first two limitations of this research.
2. As the survey data relied mainly on respondents' memories it is suggested that a "test-retest" approach (as described by Leedy and Ormrod, 2005) be adopted to confirm the validity and reliability of the results obtained in this study. This can be done by surveying different individuals within the same respondent companies, or using an alternative sample set.
3. Further work is required to confirm the proposed associations between CSFs and ERP benefits. It is recommended that these, and other, associations be tested using a larger sample set.
4. The literature reviewed places little emphasis on the Learning & Growth benefits from ERP systems. However, this study shows that these benefits are being achieved to a "medium" extent. It is therefore recommended that more focus be placed on investigating the Learning & Growth benefits available through ERP implementations.
5. This study assessed benefits based on a seven point Likert scale. Although this scale was effective in determining if benefits have been achieved, it did not provide a means to quantify benefits back to the overall strategic goal (i.e. effect on net profit). It is therefore suggested that further research be conducted to develop the cause-and-effect tree surrounding the ERP Time-Based BSC, to aid in quantifying the impact of individual benefits on organisation performance/net profit.
6. A possible source of bias in the results was noted to be the benefits from enabling systems being attributed solely to ERP systems. Whereas, a

detailed analysis from this point of view is out of the scope of this study, it is recommended that further research investigate this possibility using the results of this study for comparative purposes.

7. If the ERP Time-Based BSC is to gain further use in business or research, it is suggested that its validity and reliability receive further testing (specifically for the Financial Perspective and Learning & Growth Perspective where Cronbach's α values were shown to be below 0.8).

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APPENDIX A: MARKET RESEARCH POPULATION AND SAMPLE SET

This appendix includes the data used to determine the total population size and sample set for the market research. Table A1 and A2 are used to estimate the population size and Table A3 defines the sample set:

Table A1 displays the Financial Mail's Top 200 listed companies (Financial Mail, 2008). The sector that each company falls into is defined according to Hutton et al (2008). This sector classification combined with Hutton et al's (2008) description of each organisation's core operations has been used to determine if the organisation can be classified within the manufacturing sector. (The "Manu sector" column indicates if an organisation can be classified within the manufacturing sector. The "Manu Count" column provides a running total of the organisations that are grouped into the manufacturing sector.)

Table A2 contains the statistics on the number of manufacturing organisations with an annual revenue above R300 million (Statistics South Africa, 2008).

Table A3 contains the details of the sample set that was contacted to participate in the market research. The "On Top 200 List" column indicates whether or not the companies within the sample set are on the Financial Mail's Top 200 list. The "Questionnaire Returned" column indicates if the individual contacted completed and returned the questionnaire. All contact information has been removed from this list to ensure the confidentiality of the participants. These details are held by the WITS Industrial Engineering Department (c/o Prof. D.R. Snaddon).

Table A1 Top 200 JSE listed companies

Top 200 Order	Company Full	Turnover (R mil)	Financial Report Date	Sector *	Manu Sector	Manu Count
1	BHP Billiton Plc	278 154,9	Jun-07	Basic Materials - Basic resourses - Mining - General Mining	Y	1
2	Anglo American Plc	232 901,4	Dec-06	Basic Materials - Basic Resourses - Mining - General Mining	Y	2
3	SABMiller Plc	135 912,4	Mar-07	Consumer Goods - Food & Beverage - Beverages - Brewers	Y	3
4	Sasol Ltd	98 127,0	Jun-07	Oil & Gas - Oil & Gas - Oil & Gas Producers - Integrated Oil & Gas	Y	4
5	The Bidvest Group Ltd	95 655,5	Jun-07	Industrials - Industrial Goods & Services - Support Services - Business Support Services	N	
6	Sanlam Ltd	83 686,0	Dec-06	Financials - Insurance - Life Insurance - Life Insurance	N	
7	Standard Bank Group Ltd	69 262,0	Dec-06	Financials - Banks - Banks - Banks	N	
8	Imperial Holdings Ltd	66 214,0	Jun-07	Industrials - Industrial Goods & Services - Industrial Transportation - Transportation Services	N	
9	Old Mutual Plc	65 458,3	Dec-06	Financials - Insurance - Life Insurance - Life Insurance	N	
10	FirstRand Ltd	63 021,0	Jun-07	Financials - Banks - Banks - Banks	N	
11	Telkom SA Ltd	51 619,0	Mar-07	Telecommunications - Telecommunications - Fixed Line Telecommunications - Fixed Line	N	
12	MTN Group Ltd	51 595,0	Dec-06	Telecommunications - Telecommunications - Mobile Telecommunications - Mobile Telecommunications	N	
13	Barloworld Ltd	50 259,0	Sep-07	Industrials - Industrial Goods & Services - General Industrials - Diversified Industrials	Y	5
14	Absa Group Ltd	49 819,0	Dec-06	Finacials - Banks - Banks - Banks	N	
15	Anglo American Platinum Corporation Ltd	46 961,0	Dec-07	Basic Materials - Basic Resourses - Mining - Platinum & Precious Metals	Y	6
16	Richemont Securities AG	46 864,1	Mar-07	Consumer Goods - Personal & Household Goods - Personal Goods - Apparel Retailers	N	
17	Pick n Pay Stores Ltd	39 337,1	Feb-07	Consumers Services - Retail - Food & Drug Retailers - Food Retailers & Wholesalers	N	
18	Pick n Pay Holdings Ltd	39 337,1	Feb-07	Consumers Services - Retail - Food & Drug Retailers - Food Retailers & Wholesalers	N	
19	Shoprite Holdings Ltd	38 949,8	Jun-07	Consumers Services - Retail - Food & Drug Retailers - Food Retailers & Wholesalers	N	
20	Nedbank Group Ltd	37 206,0	Dec-06	Financials - Banks - Banks - Banks	N	
21	Steinhoff International Holdings Ltd	36 649,7	Jun-07	Consumer Goods - Personal & Household Goods - Houehold Goods - Furnishings	Y	7
22	Sappi Ltd	35 042,6	Sep-06	Basic Materials - Basic Resources - Forestry & Paper - Paper	Y	8
23	Massmart Holdings Ltd	34 807,6	Jun-07	Consumer Services - Retail - General Retailers - Broadline Retailers	N	
24	Impala Platinum Holdings Ltd	31 481,5	Jun-07	Basic Materials - Basic Resources - Mining - Platinum & Precious Metals	Y	9
25	Liberty Holdings Ltd	27 901,0	Dec-06	Financials - Insurance - Life Insurance - Life Insurance	N	

* Sector as defined by Hutton et al (2008) in Profile's Stock Exchange Handbook

Table A1 continued...

Top 200 Order	Company Full	Turnover (R mil)	Financial Report Date	Sector *	Manu Sector	Manu Count
26	Liberty Group Ltd	27 901,0	Dec-06	Financials - Insurance - Life Insurance - Life Insurance	N	
27	Dimension Data Holding Plc	26 021,8	Sep-07	Technology - Technology - Software & Computer Services - Computer Services	Y	10
28	Investec Bank Ltd	25 871,4	Mar-07	Financials - Financial Services - General Financial - Investment Services	N	
29	Investec Plc	25 871,4	Mar-07	Financials - Financial Services - General Financial - Investment Services	N	
30	ArcelorMittal SA Ltd	25 363,0	Dec-06	Basic Materials - Basic Resources - Industrial Metals - Steel	Y	11
31	Datatec Ltd	22 954,9	Feb-07	Technology - Technology - Software & computer Services - Computer Services	N	
32	Aveng Ltd	22 093,3	Jun-07	Industrials - Construction & Materials - Construction & Materials - Heavy Construction	Y	12
33	The Spar Group Ltd	21 704,0	Sep-07	Consumers Services - Retail - Food & Drug Retailers - Food Retailers & Wholesalers	N	
34	AngloGold Ashanti Ltd	20 886,0	Dec-06	Basic Materials - Basic Resources - Mining - Gold Mining	Y	13
35	Gold Fields Ltd	19 693,1	Jun-07	Basic Materials - Basic Resources - Mining - Gold Mining	Y	14
36	Naspers Ltd	19 508,1	Mar-07	Consumer Services - Media - Media - Broadcasting & Entertainment	N	
37	Network Healthcare Holdings Ltd	18 607,0	Sep-07	Health Care - Health Care - Health Care Equipment & Services - Health Care Providers	N	
38	Murray & Roberts Holdings Ltd	18 588,8	Jun-07	Industrials - Construction & Materials - Construction & Materials - Heavy Construction	N	
39	Woolworths Holdings Ltd	17 376,9	Jun-07	Consumer Services - Retail - General Retailers - Broadline Retailers	N	
40	Allied Electronics Corporation Ltd	17 126,0	Feb-07	Industrials - Industrial Goods & Services - Electrical & Electrical Equipment - Components & Equipment	Y	15
41	Nampak Ltd	17 014,4	Sep-07	Industrials - Industrial Goods & Services - General Industrials - Containers & Packaging	Y	16
42	Tiger Brands Ltd	16 209,9	Sep-07	Consumer Goods - Food & Beverage - Food Producers - Food Products	Y	17
43	Exxaro Resources Ltd	13 746,0	Dec-06	Basic Materials - Basic Resources - Mining - General Mining	Y	18
44	Lonmin Plc	13 386,2	Sep-07	Basic Materials - Basic Resources - Mining - Platinum & Precious Metals	Y	19
45	Kumba Iron Ore Ltd	13 026,0	Dec-06	Basic Minerals - Basic Resources - Mining - General Mining	Y	20
46	JD Group Ltd	12 907,0	Aug-07	Consumer Services - Retail - General Retailers - Home Improvement Retailers	N	
47	Santam Ltd	12 736,0	Dec-06	Financials - Insurance - Life Insurance - Life Insurance	N	
48	Grindrod Ltd	12 504,0	Dec-06	Industrials - Industrial Goods & Services - Industrial Transportation - MarineTransportation	N	
49	Oando Plc	11 604,5	Dec-06	Oil & Gas - Oil & Gas - Oil & Gas Producers - Integrated Oil & Gas	Y	21
50	Super Group Ltd	11 575,0	Jun-07	Industrials - Industrial Goods & Services - Industrial Transportation - Transportation Services	N	

Table A1 continued...

Top 200 Order	Company Full	Turnover (R mil)	Financial Report Date	Sector *	Manu Sector	Manu Count
51	New Clicks Holdings Ltd	11 204,9	Aug-07	Consumer Services - Retail - General Retailers - Broadline Retailers	N	
52	AECI Ltd	10 212,0	Dec-06	Basic Materials - Chemicals - Chemicals - Speciality Chemicals	Y	22
53	Reunert Ltd	9 445,4	Sep-07	Industrials - Industrial Goods & Services - Electronic & Electrical Equipment - Electronic Components &	Y	23
54	Harmony Gold Mining Company Ltd	9 148,0	Jun-07	Basic Materials - Basic Resources - Mining - Gold Mining	Y	24
55	Combined Motor Holdings Ltd	9 085,6	Feb-07	Consumer Services - Retail - General Retailers - Speciality Retailers	N	
56	Mutual & Federal Insurance Co Ltd	8 549,0	Dec-06	Financials - Insurance - Nonlife Insurance - Property & Casuality	N	
57	Wilson Bayly Holmes-Ovcon Ltd	8 127,8	Jun-07	Industrials - Construction & Materials - Construction & Materials - Heavy Construction	N	
58	Remgro Ltd	7 877,0	Mar-07	Industrials - Industrial Goods & Services - General Industrials - Diversified Industrials	N	
59	Tongaat Hulett Ltd	7 848,0	Dec-06	Consumer Goods - Food & Beverage - Food Producers - Food Products	Y	25
60	Liberty International Plc	7 816,7	Dec-06	Financials - Financial Services - Real Esate - Investment Trusts	N	
61	Group Five Ltd	7 689,2	Jun-07	Industrials - Construction & Materials - Construction & Materials - Heavy Construction	Y	26
62	Metropolitan Holdings Ltd	7 423,0	Dec-06	Financials - Insurance - Life Insurance - Life Insurance	N	
63	Foschini Ltd	7 230,0	Mar-07	Consumer Services - Retail - General Retailers - Apparels	N	
64	Sun International Ltd	6 937,0	Jun-07	Consumer Services - Travel & Leisure - Travel & Leisure - Gambling	N	
65	Highveld Steel & Vanadium Corporation Ltd	6 901,0	Dec-06	Basic Materials - Basic Resources - Industrial Metals - Steel	Y	27
66	Allied Technologies Ltd	6 780,0	Feb-07	Telecommunications - Telecommunications - Mobile Telecommunications - Mobile Telecommunications	N	
67	Afgri Ltd	6 530,1	Feb-07	Consumer Goods - Food & Beverage - Food Producers - Farming & Fishing	Y	28
68	AVI Ltd	6 332,4	Jun-07	Consumer Goods - Food & Beverage - Food Producers - Food	Y	29
69	Astral Foods Ltd	6 329,3	Sep-07	Consumer Goods - Food & Beverage - Food Producers - Farming & Fishing	Y	30
70	Illovo Sugar Ltd	6 263,6	Mar-07	Consumer Goods - Food & Beverage - Food Producers - Food Products	Y	31
71	Distell Group Ltd	6 231,2	Jun-07	Consumer Goods - Food & Beverage - Beverages - Distillers & Vintners	Y	32
72	Mr Price Group Ltd	6 155,0	Mar-07	Consumer Services - Retail - General Retailers - Apparels	N	
73	African Rainbow Minerals Ltd	6 152,0	Jun-07	Basic Materials - Basic Resources - Mining - General Mining	Y	33
74	Pretoria Portland Cement Company Ltd	5 566,0	Sep-07	Industrials - Construction & Materials - Construction & Materials - Building Materials &	Y	34
75	Omnia Holdings Ltd	5 537,1	Mar-07	Basic Materials - Chemicals - Chemicals - Speciality Chemicals	Y	35

Table A1 continued...

Top 200 Order	Company Full	Turnover (R mil)	Financial Report Date	Sector *	Manu Sector	Manu Count
76	Medi-Clinic Corporation Ltd	5 364,0	Mar-07	Health Care - Health Care - Health Care Equipment & Services - Health Care Providers	N	
77	Element1	5 359,0	Mar-07	Consumer Services - Media - Media	N	
78	Discovery Holdings Ltd	5 166,0	Jun-07	Financials - Insurance - Life Insurance - Life Insurance	N	
79	Aquarius Platinum Ltd	4 859,2	Jun-07	Basic Materials - Basic Resourses - Mining - Platinum & Precious Metals	Y	36
80	Truworths International Ltd	4 858,0	Jun-07	Consumer Goods - Retail - General Retailers - Apparel Retailers	N	
81	Rainbow Chicken Ltd	4 730,4	Mar-07	Consumer Goods - Food & Beverage - Food Producers - Farming & Fishing	Y	37
82	Hosken Consolidated Investments Ltd	4 382,9	Mar-07	Financials - Investment Instruments - Equities - Equities	N	
83	Assore Ltd	4 293,0	Jun-07	Basic Materials - Basic Resourses - Mining - General Mining	Y	38
84	Aspen Pharmacare Holdings Ltd	4 025,9	Jun-07	Health Care - Health Care - Pharmaceuticals & Biotechnology - Pharmaceuticals	Y	39
85	Caxton CTP Publishers & Printers Ltd	4 006,4	Jun-07	Consumer Services - Media - Media - Publishing	Y	40
86	Palabora Mining Company Ltd	3 981,9	Dec-06	Basic Materials - Basic Resources - Industrial Metals - Nonferrous	Y	41
87	African Oxygen Ltd	3 914,0	Sep-06	Basic Materials - Chemicals - Chemicals - Speciality Chemicals	Y	42
88	Zurich Insurance Company SA Ltd	3 910,6	Dec-06	Financials - Insurance - Nonlife Insurance - Property & Casuality	N	
89	Seardel Investment Corporation Ltd	3 793,4	Jun-07	Consumer Goods - Personal & Household Goods - Personal Goods - Apparel Retailers	N	
90	Northam Platinum Ltd	3 739,8	Jun-07	Basic Materials - Basic Resources - Mining - Platinum & Precious Metals	Y	43
91	Tradehold Ltd	3 725,2	Feb-07	Cosumer Services - Retail - General Retailers - Broadline Retailers	N	
92	Business Connexion Group Ltd	3 551,1	May-07	Technology - Technology - Software & computer Services - Computer Services	N	
93	Bell Equipment Ltd	3 533,2	Dec-06	Industrials - Industrial Goods & Services - Industrial Engineering - Vehicles & Trucks	Y	44
94	KAP International Holdings Ltd	3 494,8	Jun-07	Industrials - Industrial Goods & Services - General Industrials - Diversified Industrials	Y	45
95	Mvelaphanda Group Ltd	3 461,6	Jun-07	Industrials - Industrial Goods & Services - Support Services - Business Support Services	N	
96	Iliad Africa Ltd	3 368,4	Dec-06	Industrials - Indsutrial Goods & Services - Support Services - Industrial Suppliers	N	
97	Mustek Ltd	3 354,7	Jun-07	Technology - Technology - Technology Hardware & Equipment - Computer Hardware	N	
98	Lewis Group Ltd	3 323,5	Mar-07	Consumer Services - Retail - General Retailers - Home Improvement Retailers	N	
99	African Bank Investments Ltd	3 268,0	Sep-07	Finacials - Financial Services - General Financial - Consumer Finance	N	
100	Distribution & Warehousing Network Ltd	3 002,5	Jun-07	Industrials - Construction & Materials - Construction & Materials - Building Materials &	Y	46

Table A1 continued...

Top 200 Order	Company Full	Turnover (R mil)	Financial Report Date	Sector *	Manu Sector	Manu Count
101	Cashbuild Ltd	2 710,4	Jun-06	Consumer Services - Retail - General Retailers - Home Improvement Retailers	N	
102	Adcorp Holdings Ltd	2 700,2	Dec-06	Industrials - Industrial Goods & Services - Support Services - - Business Training & Employment	N	
103	Invicta Holdings Ltd	2 663,4	Mar-07	Industrials - Industrial Goods & Services - Industrial Engineering - Industrial Machinery	N	
104	Metair Investments Ltd	2 641,9	Dec-06	Consumer Goods - Automobiles & Parts - Automobiles & Parts - Auto Parts	Y	47
105	Oceana Group Ltd	2 608,9	Sep-07	Consumer Goods - Food & Beverage - Food Producers - Farming & Fishing	Y	48
106	Growthpoint Properties Ltd	2 362,0	Jun-07	Financials - Financial Services - Real Estate - Holdings & Development	N	
107	Phumelela Gaming & Leisure Ltd	2 296,6	Jul-07	Consumer Services - Travel & Leisure - Travel & Leisure - Gambling	N	
108	Metorex Ltd	2 286,5	Jun-07	Basic Minerals - Basic Resources - Mining - General Mining	Y	49
109	Hudaco Industries Ltd	2 226,9	Nov-07	Industrials - Industrial Goods & Services - Industrial Engineering - Industrial Machinery	Y	50
110	Astrapak Ltd	2 223,1	Feb-07	Industrials - Industrial Goods & Services - General Industrials - Containers & Packaging	Y	51
111	Comair Ltd	2 211,7	Jun-07	Consumer Services - Travel & Leisure - Travel & Leisure - Airlines	N	
112	DRDGold Ltd	2 209,7	Jun-07	Basic Materials - Basic Resources - Mining - Gold Mining	Y	52
113	Trencor Ltd	2 041,4	Dec-06	Industrials - Industrial Goods & Services - Industrial Transportation - Transportation Services	N	
114	Gijima AST Group Ltd	2 017,4	Jun-07	Technology - Technology - Software & Computer Services - Computer Services	N	
115	The Kelly Group Ltd	1 994,0	Sep-07	Industrials - Industrial Goods & Services - Support Services - Training & Employment	N	
116	Amalgamated Appliance Holdings Ltd	1 979,7	Jun-07	Consumer Goods - Personal & Household Goods - Liesure Goods - Consumer Electronics	Y	53
117	Nu-World Holdings Ltd	1 865,8	Aug-07	Consumer Goods - Personal & Household Goods - Liesure Goods - Consumer Electronics	N	
118	Pinnacle Technology Holdings Ltd	1 715,8	Jun-07	Technology - Technology - Technology Hardware & Equipment - Computer Hardware	N	
119	Tourism Investment Corporation Ltd	1 639,4	Jun-07	Consumer Services - Travel & Leisure - Travel & Leisure - Travel & Tourism	N	
120	Gold Reef Casino Resorts Ltd	1 517,1	Dec-06	Consumer Services - Travel & Leisure - Travel & Leisure - Gambling	N	
121	Italtile Ltd	1 477,0	Jun-07	Consumer Services - Retail - General Retailers - Home Improvement Retailers	N	
122	Ceramic Industries Ltd	1 375,4	Jul-07	Industrials - Costruction & Materials - Costruction & Materials - Building Materials & Fixtures	Y	54
123	Sentula Mining Ltd	1 368,8	Mar-07	Basic Minerals - Basic Resources - Mining - General Mining	Y	55
124	PSG Group Ltd	1 343,7	Feb-07	Finnancials - Financial Services - General Financial - Investment Services	N	
125	Country Foods Ltd	1 309,2	Jun-07	ALTX (Holding company (food & bev))	N	

Table A1 continued...

Top 200 Order	Company Full	Turnover (R mil)	Financial Report Date	Sector *	Manu Sector	Manu Count
126	Argent Industrial Ltd	1 296,3	Mar-07	Industrials - Industrial Goods & Services - General Industrials - Diversified Industrials	Y	56
127	Santova Logistics Ltd	1 244,5	Feb-07	ALTX (Logistics Service Provider)	N	
128	ApexHi Properties Ltd	1 210,1	Jun-07	Financials - Financial Services - Real Estate - Holdings & Development	N	
129	Datacentrix Holdings Ltd	1 201,9	Feb-07	Technology - Technology - Software & computer Services - Computer Services	N	
130	Raubex Group Ltd	1 190,9	Feb-07	Industrials - Construction & Materials - Construction & Materials - Heavy Construction	N	
131	Basil Read Holdings Ltd	1 162,2	Dec-06	Industrials - Construction & Materials - Construction & Materials - Heavy Construction	N	
132	AG Industries Ltd	1 151,1	Jun-07	Industrials - Construction & Materials - Construction & Materials - Building Materials & Fixtures	Y	57
133	Capitec Bank Holdings Ltd	1 138,1	Feb-07	Finacials - Banks - Banks - Banks	N	
134	UCS Group Ltd	1 070,5	Sep-07	Technology - Technology - Software & Computer Services - Software	N	
135	House of Busby Ltd	1 062,3	Jun-07	Cosumer Goods - Personal & Household Goods - Personal Goods - Apparel Retailers	N	
136	Conduit Capital Ltd	1 044,3	Aug-07	Financials - Financial Services - General Financial - Speciality Finance	N	
137	Trans Hex Group Ltd	1 035,8	Mar-07	Basic Materials - Basic Resources - Mining - Diamonds & Gems	N	
138	Value Group Ltd	1 034,0	Feb-07	Industrials - Industrial Goods & Services - Industrial Transportation - Transportation Services	N	
139	Merafe Resources Ltd	1 030,5	Dec-06	Basic Minerals - Basic Resources - Mining - General Mining	Y	58
140	Vox Telecom Ltd	990,1	Aug-07	Telecommunications - Telecommunications - Voice & Data	N	
141	ELB Group Ltd	983,4	Jun-07	Industrials - Construction & Materials - Construction & Materials - Heavy Construction	N	
142	Dorbyl Ltd	962,1	Mar-07	Consumers Goods - Automobiles & Parts - Auto Parts	Y	59
143	Coronation Fund Managers Ltd	962,0	Sep-07	Financials - Financial Services - General Financial - Asset Managers	N	
144	Winhold Ltd	917,2	Sep-07	Industrials - Industrial Goods & Services - Support Services - Industrial Suppliers	N	
145	EnviroServ Holdings Ltd	873,8	Jun-07	Industrials - Industrial Goods & Services - Support Services - Waste & Disposal Services	N	
146	Famous Brands Ltd	872,2	Feb-07	Consumer Services - Travel & Leisure - Travel & Leisure - Restuarants & Bars	Y	60
147	Workforce Holdings Ltd	860,5	Dec-06	ALTX (Personnel Placement)	N	
148	Faritec Holdings Ltd	858,3	Jun-07	Technology - Technology - Software & Computer Services - Computer Services	N	
149	ADvTech Ltd	830,5	Dec-06	Consumer Services - Retail - General Retailers - Spec Comsumer Sevices	N	
150	Paracon Holdings Ltd	792,3	Sep-07	Technology - Technology - Software & Computer Services - Computer Services	N	

Table A1 continued...

Top 200 Order	Company Full	Turnover (R mil)	Financial Report Date	Sector *	Manu Sector	Manu Count
151	Enaleni Pharmaceuticals Ltd	789,5	Dec-06	Health Care - Health Care - Pharmaceuticals & Biotechnology - Pharmaceuticals	Y	61
152	Peregrine Holdings Ltd	778,9	Mar-07	Financials - Financial Services - General Financial - Investment Services	N	
153	Control Instruments Group Ltd	772,2	Dec-06	Industrials - Industrial Goods & Services - Electronic & Electrical Equipment - Electronic Equipment	Y	62
154	Kagiso Media Ltd	738,3	Jun-07	Consumer Services - Media - Media - Broadcasting & Entertainment	N	
155	Eastern Platinum Ltd	712,7	Jun-07	Basic Materials - Basic Resources - Mining - Platinum & Precious Metals	Y	63
156	Mercantile Lisbon Bank Ltd	708,9	Dec-07	Financials - Banks - Banks - Banks	N	
157	Enterprise Outsourcing Holdings Ltd	703,7	Jul-07	Technology - Technology - Software & computer Services - Computer Services	N	
158	Emira Property Fund	631,0	Jun-07	Financials - Financial Services - Real Estate - Investment Trusts	N	
159	Hyprop Investments Ltd	630,3	Dec-06	Financials - Financial Services - Real Estate - Holdings & Development	N	
160	Monteagle Societé Anonyme	623,8	Sep-07	Industrials - Industrial Goods & Services - Industrial Transportation - Transportation Services	N	
161	Clientele Life Assurance Company Ltd	623,5	Jun-07	Financials - Insurance - Life Insurance - Life Insurance	N	
162	Fountainhead Prop Trust	606,5	Sep-07	Financials - Financial Services - Real Estate - Investment Trusts	N	
163	Pangbourne Properties Ltd	605,7	Jun-07	Financials - Financial Services - Real Estate - Holdings & Development	N	
164	Simmer & Jack Mines Ltd	602,9	Mar-07	Basic Minerals - Basic Resources - Mining - General Mining	Y	64
165	Sasfin Holdings Ltd	596,0	Jun-07	Financials - Financial Services - General Financials - Investment Services	N	
166	Alert Steel Holdings Ltd	566,0	Jun-07	Altx - mostly retail, some manufacturing	N	
167	Celcom Group Ltd	555,2	Jun-07	ALTX (Cellular Communications)	N	
168	Vukile Property Fund Ltd	553,5	Mar-07	Financials - Financial Services - Real Estate - Holdings & Development	N	
169	Transpaco Ltd	541,7	Jun-07	Industrials - Industrial Goods & Services - General Industrials - Containers & Packaging	Y	65
170	Glenrand MIB Ltd	516,5	Jun-07	Financials - Insurance - Nonlife Insurance - Insurance Brokers	N	
171	Howden Africa Holdings Ltd	510,9	Dec-06	Industrials - Industrial Goods & Services - Industrial Engineering - Industrial Machinery	Y	66
172	City Lodge Hotels Ltd	509,7	Jun-07	Consumer Services - Travel & Leisure - Travel & Leisure - Hotels	N	
173	Excellerate Holdings Ltd	494,8	Jun-07	Industrials - Industrial Goods & Services - Support Services - Business Support Services	N	
174	Redefine Income Fund Ltd	488,8	Aug-07	Financials - Financial Services - Real Estate - Holdings & Development	N	
175	Delta Electrical Industries Ltd	486,1	Dec-07	Industrials - Industrial Goods & Services - Electronic & Electrical Equipment - Electronic Components &	Y	67

Table A1 continued...

Top 200 Order	Company Full	Turnover (R mil)	Financial Report Date	Sector *	Manu Sector	Manu Count
176	Sovereign Food Investments Ltd	458,7	Feb-07	Consumer Goods - Food & Beverage - Food Producers - Farming & Fishing	Y	68
177	Sekunjalo Investments Ltd	449,5	Aug-07	Industrial - Industrial Goods & Services - General Industrials - Diversified Industrials	N	
178	Simeka BSG Ltd	447,0	May-07	ALTX (ICT Consulting & Applications)	N	
179	Digicore Holdings Ltd	440,7	Jun-07	Industrials - Industrial Goods & Services - Electronic & Electrical Equipment - Electronic Equipment	Y	69
180	Masonite (Africa) Ltd	432,0	Dec-06	Industrials - Costruction & Materials - Costruction & Materials - Building Materials & Fixtures	Y	70
181	Bowler Metcalf Ltd	427,2	Jun-07	Industrials - Industrial Goods & Services - General Industrials Containers & Packaging	Y	71
182	Cargo Carriers Ltd	426,4	Feb-07	Industrials - Industrial Goods & Services - Industrial Transportation - Trucking	N	
183	Set Point Technology Holdings Ltd	407,5	Aug-07	Industrials - Industrial Goods & Services - Electronic & Electrical Equipment - Electronic Components &	Y	72
184	Jasco Electronics Holdings Ltd	400,7	Feb-07	Industrials - Industrial Goods & Services - Electronic & Electrical Equipment - Electronic Components &	Y	73
185	York Timber Organisation Ltd	394,0	Dec-06	Basic Materials - Basic Resources - Forestry & Paper - Forestry	N	
186	African & Overseas Enterprises Ltd	390,6	Jun-07	Consumer Services - Retail - General Retailers - Apparels	N	
187	Rex Trueform Clothing Company Ltd	390,6	Jun-07	Consumer Services - Retail - General Retailers - Apparels	N	
188	Petra Mining Ltd	382,3	Jun-07	Basic Minerals - Basic Resources - Mining - General Mining	Y	74
189	Sanyati Holdings Ltd	379,6	Feb-07	Industrials - Construction & Materials - Construction & Materials - Heavy Construction	N	
190	Barnard Jacobs Mellet Holdings Ltd	371,4	Mar-07	Finacials - Financial Services - General Financial - Investment Services	N	
191	Cullinan Holdings Ltd	353,7	Sep-07	Consumer Services - Travel & Leisure - Travel & Leisure - Travel & Tourism	N	
192	WG Wearne Ltd	352,5	Feb-07	ALTX (Produce Ready Mix Concrete)	Y	75
193	iFour Properties LTD	352,1	Jun-07	Financials - Financial Services - Real Estate - Holdings & Development	N	
194	Afrimat Ltd	349,0	Feb-07	Industrials - Construction & Materials - Construction & Materials - Building Materials &	Y	76
195	Brimstone Investment Corporation Ltd	345,4	Dec-06	Financials - Investment Instruments - Equities - Equities	N	
196	Primeserv Group Ltd	345,4	Dec-06	Industrials - Industrial Goods & Services - Support Services - Training & Employment	N	
197	Micromega Holdings Ltd	318,4	Dec-06	Industrials - Industrial Goods & Services - Support Services - Business Support Services	N	
198	Rare Holdings Ltd	317,8	Jun-07	ALTX (Manufacturing & Distribution of Piping)	Y	77
199	Metrofile Holdings Ltd	299,7	Jun-07	Industrials - Industrial Goods & Services - Support Services - Business Support Services	N	
200	B&W Instrumentation & Electrical Ltd	294,0	Aug-07	ALTX (Heavy Construction)	N	

Table A2 SA manufacturing firms with revenue >R300 million pa

Sic_Code	(All)
Sic Description	(All)
Activity	(All)
Country of Registration	(All)
Listed	(All)
Company Type	(All)
Economically Active	Yes
Company Classification	(All)
Main Classification	(Multiple Items)
General Classification	B7-R300M-Plus

Includes manufacturing, mining, electricity gas and water

Sum of Companies	
Province	Total
EASTERN CAPE	14
GAUTENG	184
KWAZULU NATAL	20
MPUMALANGA	3
NORTH WEST PROVINCE	2
NORTHERN CAPE	1
NORTHERN PROVINCE	2
UnKnwon	15
WESTERN CAPE	20
Grand Total	261

Statistics South Africa (2008)

Table A3 Market research sample set

Company Name	Contact Person	Position	Telephone	Email	On Top 200 List	Questionnaire Returned
AECI Ltd	*Confidential*	IT Manager	*Confidential*	*Confidential*	✓	
Afgri Ltd	*Confidential*	Group Financial Director	*Confidential*	*Confidential*	✓	
African Oxygen Ltd	*Confidential*	GM Information Services	*Confidential*	*Confidential*	✓	✓
African Rainbow Minerals Ltd	*Confidential*	Chief Financial Officer	*Confidential*	*Confidential*	✓	
AfriSam (South Africa) (Pty) Ltd	*Confidential*	Chief Information Officer	*Confidential*	*Confidential*		✓
AG Industries Ltd	*Confidential*	Group Financial Director	*Confidential*	*Confidential*	✓	
Allied Electronics Corporation Ltd	*Confidential*	Chief Financial Officer	*Confidential*	*Confidential*	✓	
Amalgamated Beverage Industries (ABI) Ltd	*Confidential*	Managing Director	*Confidential*	*Confidential*		✓
Amka Products (Pty) Ltd	*Confidential*	Financial Director	*Confidential*	*Confidential*		
Anglo American Platinum Corporation Ltd	*Confidential*	Operations	*Confidential*	*Confidential*	✓	
Appletiser (S A) (Pty) Ltd	*Confidential*	Financial Director	*Confidential*	*Confidential*		✓
ArcelorMittal SA Ltd	*Confidential*	Finance Director	*Confidential*	*Confidential*	✓	
Aspen Pharmacare Holdings Ltd	*Confidential*	Group Logistics & Distribution Executive	*Confidential*	*Confidential*	✓	✓
Assa Abloy (S A) (Pty) Ltd	*Confidential*	Financial Director	*Confidential*	*Confidential*		
Astrapak Ltd	*Confidential*	Chief Financial Officer	*Confidential*	*Confidential*	✓	
Automotive Leather Co (Pty) Ltd	*Confidential*	Financial Director	*Confidential*	*Confidential*		
Aveng Ltd	*Confidential*	Group Financial Director	*Confidential*	*Confidential*	✓	
AVI Ltd	*Confidential*	Strategic Sourcing Director	*Confidential*	*Confidential*	✓	✓
Barloworld Ltd	*Confidential*	Group SAP Manager	*Confidential*	*Confidential*	✓	✓
BASF South Africa (Pty) Ltd	*Confidential*	Chief Information Officer	*Confidential*	*Confidential*		
Bell Equipment Ltd	*Confidential*	Group Financial Director	*Confidential*	*Confidential*	✓	
BHP Billiton Plc	*Confidential*	CEO	*Confidential*	*Confidential*	✓	
BMW South Africa (Pty) Ltd	*Confidential*	M D: BMW Financial Services	*Confidential*	*Confidential*		
Bridgestone South Africa (Pty) Ltd	*Confidential*	Chief Information Officer	*Confidential*	*Confidential*		
British American Tobacco (S A) (Pty) Ltd	*Confidential*	ERP Optimisation Manager	*Confidential*	*Confidential*		✓
British Pretrolium SA (PTY) Ltd	*Confidential*	Financial Director	*Confidential*	*Confidential*		

Note: information marked as confidential is held by the WITS Industrial Engineering Department (c/o Prof. D.R. Snaddon)

Table A3 continued...

Company Name	Contact Person	Position	Telephone	Email	On Top 200 List	Questionnaire Returned
Cadbury SA (Pty) Ltd	*Confidential*	Financial Director	*Confidential*	*Confidential*		
Clover SA (Pty) Ltd	*Confidential*	Procurement Manager	*Confidential*	*Confidential*		✓
Coates Brothers SA Ltd	*Confidential*	Finance & Business Development Director	*Confidential*	*Confidential*		✓
Coca-Cola Canners of SA Pty (Ltd)	*Confidential*	Procurement Manager	*Confidential*	*Confidential*		
Colgate Palmolive Company Ltd	*Confidential*	IT Director	*Confidential*	*Confidential*		
Columbus Stainless (Pty) Ltd	*Confidential*	Chief Information Officer	*Confidential*	*Confidential*		
Consol Ltd	*Confidential*	IT Director	*Confidential*	*Confidential*		
Control Instruments Group Ltd	*Confidential*	Chief Financial Officer	*Confidential*	*Confidential*	✓	
Dimension Data Holding Plc	*Confidential*	Chief Information Officer	*Confidential*	*Confidential*	✓	✓
Distell Group Ltd	*Confidential*	Chief Information Officer	*Confidential*	*Confidential*	✓	
Dorbyl Ltd	*Confidential*	Chief Financial Officer	*Confidential*	*Confidential*	✓	
Dunlop Tyres International (Pty) Ltd	*Confidential*	Financial Director	*Confidential*	*Confidential*		
Eastern Platinum Ltd	*Confidential*	Chief Financial Officer	*Confidential*	*Confidential*	✓	
Enaleni Pharmaceuticals Ltd	*Confidential*	Chief Financial Officer	*Confidential*	*Confidential*	✓	
Engen Petroleum Ltd	*Confidential*	Financial Director	*Confidential*	*Confidential*		
Eskom Holdings Ltd	*Confidential*	ERP Manager	*Confidential*	*Confidential*		
Exxaro Resources Ltd	*Confidential*	Chief Financial Officer	*Confidential*	*Confidential*	✓	
Famous Brands Ltd	*Confidential*	Finance Director	*Confidential*	*Confidential*	✓	
Foodcorp (Pty) Ltd	*Confidential*	Financial Director	*Confidential*	*Confidential*		
Ford Motor Company of SA (Pty) Ltd	*Confidential*	Chief Information Officer	*Confidential*	*Confidential*		
Foskor Pty Ltd (Phalaborwa Division)	*Confidential*	Group ITC Manager	*Confidential*	*Confidential*		✓
Fraser Alexander (Pty) Ltd	*Confidential*	Group Financial Director	*Confidential*	*Confidential*		
Glaxosmithkline (Pty) Ltd	*Confidential*	Procurement Manager	*Confidential*	*Confidential*		
Gold Fields Ltd	*Confidential*	Operations	*Confidential*	*Confidential*	✓	
Group Five Ltd	*Confidential*	Chief Information Officer	*Confidential*	*Confidential*	✓	
Harmony Gold Mining Company Ltd	*Confidential*	Interim Finance Director	*Confidential*	*Confidential*	✓	

Table A3 continued...

Company Name	Contact Person	Position	Telephone	Email	On Top 200 List	Questionnaire Returned
Highveld Steel & Vanadium Corporation Ltd	*Confidential*	Chief Financial Officer	*Confidential*	*Confidential*	✓	
Hudaco Industries Ltd	*Confidential*	Financial Director	*Confidential*	*Confidential*	✓	
Hulamin (Pty) Ltd	*Confidential*	Chief Information Officer	*Confidential*	*Confidential*		
Illovo Sugar Ltd	*Confidential*	Financial Director	*Confidential*	*Confidential*	✓	
Impala Platinum Holdings Ltd	*Confidential*	Metal Accounting Manager	*Confidential*	*Confidential*	✓	✓
KAP International Holdings Ltd	*Confidential*	Chief Financial Officer	*Confidential*	*Confidential*	✓	
Kelloggs (Pty) Ltd	*Confidential*	Supply Chain Manager	*Confidential*	*Confidential*		
Komatsu Sothern Africa (Pty) Ltd	*Confidential*	Chief Information Officer	*Confidential*	*Confidential*		
Mondi Ltd	*Confidential*	IT Director	*Confidential*	*Confidential*		
Nampak Ltd	*Confidential*	Chief Information Officer	*Confidential*	*Confidential*	✓	✓
Nampak Tissue (Pty) Ltd	*Confidential*	Supply Chain Director	*Confidential*	*Confidential*		✓
Nestle SA (Pty) Ltd	*Confidential*	Supply & Demand Manager	*Confidential*	*Confidential*		✓
Omnia Holdings Ltd	*Confidential*	Financial Director	*Confidential*	*Confidential*	✓	
Palabora Mining Company Ltd	*Confidential*	Chief Financial Officer	*Confidential*	*Confidential*	✓	
Parmalat (S A) (Pty) Ltd	*Confidential*	Chief Financial Officer	*Confidential*	*Confidential*		
Premier Foods Ltd	*Confidential*	Chief Financial Officer	*Confidential*	*Confidential*		
Pretoria Portland Cement Company Ltd	*Confidential*	IT Manager	*Confidential*	*Confidential*	✓	
Rainbow Chicken Ltd	*Confidential*	Group Financial Director	*Confidential*	*Confidential*	✓	
SABMiller Plc	*Confidential*	Supply Chain Planning Manager	*Confidential*	*Confidential*	✓	✓
Sappi Ltd	*Confidential*	Business Manager	*Confidential*	*Confidential*	✓	
Sasol Ltd	*Confidential*	Business Optimisation Manager	*Confidential*	*Confidential*	✓	
Steinhoff International Holdings Ltd	*Confidential*	Financial Director	*Confidential*	*Confidential*	✓	
Tiger Brands Ltd	*Confidential*	IT Manager	*Confidential*	*Confidential*	✓	✓
Tongaat Hulett Ltd	*Confidential*	Chief Information Officer	*Confidential*	*Confidential*	✓	
Toyota South Africa (Pty) Ltd	*Confidential*	Operations Manager	*Confidential*	*Confidential*		
Unilever (Pty) Ltd	*Confidential*	Supply Chain Director	*Confidential*	*Confidential*		
Yeastpro (Pty) Ltd	*Confidential*	General Manager	*Confidential*	*Confidential*		

APPENDIX B: STRUCTURED INTERVIEW QUESTIONNAIRE DESIGN

Questionnaire Design Objectives

The main objectives of the design of the questionnaire were to:

1. Produce a format that would enable the ERP benefits and CSFs identified through the literature review to be evaluated by local expects.
2. Enable additional ERP benefits and CSFs, not identified through the literature review, to be collected for consideration in the market research.

Design Requirements

Building on the objectives, the design requirements are summarised as follows:

1. The questionnaire must enable the ERP benefits identified through the literature to be evaluated by the participants according to their level of confidence in each benefit being achieved by implementing organisations.
2. The questionnaire must facilitate the ranking of the identified list of CSFs according to their perceived impact on the success of an ERP implementation.
3. The ERP benefits and CSF questions must be structured in a format that enables descriptive statistics to be applied in evaluating the responses, thereby reducing the risk of bias in interpretation of the results.
4. The questionnaire must allow for additional benefits and CSFs to be identified by the respondents.
5. The questions must be constructed in a manner as to allow the interviews to be completed within an acceptable time limit to avoid interviewee fatigue (estimated to be approximately one hour).

Design Methodology

The following design methodology was followed to ensure that the design objectives were met:

1. Design requirements were taken into account.
2. A draft interview questionnaire was compiled based on the design requirements.

3. A pilot study was conducted to test the questionnaire and remedy any weaknesses.
4. A final questionnaire design was produced for use in the structured interviews.

Questionnaire Design

Draft design

Taking the above design requirements into consideration, the questionnaire displayed in Figure B1 was designed.

Design overview

The questionnaire was designed in MS Word. This package was chosen as it is used by most business professions, allowing the document to be emailed to the participants for review prior to the interviews taking place. The questionnaire begins by describing the interview objectives. This is done to remind the participant of what was discussed in the introductory telephone conversation, as they review the questionnaire in preparation for the face-to-face interviews. The body of the questionnaire consists of a combination of closed-ended questions, (adopting rating scales) to obtain verification of benefits and CSFs, and open-ended questions to obtain information not identified through the literature but applicable to the market being studied:

1. The first question makes use of a 7 point Likert scale where participants are required to indicate the extent to which they agree that the benefits should result from implementing an ERP system. By adopting the Likert scale format, the answers from the sample set can be analysed using the appropriate descriptive statistics.
2. The second question asks users to identify any ERP benefits that are not on the list, but are deemed sufficiently important to be included. The results from this question are analysed to determine if there is justification in incorporating additional benefits in the market research.
3. The third question asks users to arrange the list of CSFs according to their order of importance. At the bottom of the list there is space to add

additional CSFs not identified through the literature. This rating system enables descriptive statistics to be applied to the data to refine the list to a set of ten CSFs.

ERP BENEFITS AND CSF INTERVIEW

Interview Objectives:

The purpose of this interview is to draw on the interviewee's knowledge of working with ERP systems to determine:

1. The potential ERP benefits that should be expected from implementing an ERP system within a South African manufacturing organisation.
2. The importance of identified Critical Success Factors (CSFs) when implementing an ERP system.

Questions:

1) The following table consists of a list of possible ERP benefits. Please indicate the extent to which you agree that these benefits will result through the introduction of an ERP system to a manufacturing organisation in South Africa.

ERP Benefit	Completely Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Completely Agree
Financial Benefits							
1) Reduction in operating and admin costs	-3	-2	-1	0	1	2	3
2) Reduction in stock levels	-3	-2	-1	0	1	2	3
3) Increased turnover	-3	-2	-1	0	1	2	3
4) Reduced IT operating costs	-3	-2	-1	0	1	2	3
5) Reduced quality costs	-3	-2	-1	0	1	2	3
Internal Business Benefits							
1) Enhanced productivity and efficiencies	-3	-2	-1	0	1	2	3
2) Improved resource utilization	-3	-2	-1	0	1	2	3
3) Enhanced business processes	-3	-2	-1	0	1	2	3
4) Reduced manufacturing cycle times	-3	-2	-1	0	1	2	3
5) Reduced data processing time	-3	-2	-1	0	1	2	3
6) Increased inventory turns	-3	-2	-1	0	1	2	3
7) Improved accuracy and timeliness of information	-3	-2	-1	0	1	2	3
8) Enhanced internal information sharing	-3	-2	-1	0	1	2	3
9) Reduced manufacturing lead times	-3	-2	-1	0	1	2	3
10) Increased integration of applications	-3	-2	-1	0	1	2	3
11) Improved decision making	-3	-2	-1	0	1	2	3
12) Improved vendor performance	-3	-2	-1	0	1	2	3
Customer Benefits							
1) Improved customer service	-3	-2	-1	0	1	2	3
2) Increased on time shipments	-3	-2	-1	0	1	2	3
3) Improved quality	-3	-2	-1	0	1	2	3
4) Improved external information sharing	-3	-2	-1	0	1	2	3
5) Reduced service lead times	-3	-2	-1	0	1	2	3
Learning and Growth Benefits							
1) Increased user friendliness of IS	-3	-2	-1	0	1	2	3
2) Changed work patterns	-3	-2	-1	0	1	2	3
3) Facilitates organisational learning	-3	-2	-1	0	1	2	3
4) Empower employees to be more effective	-3	-2	-1	0	1	2	3
5) Help build a common vision	-3	-2	-1	0	1	2	3

PG 2

2) Can you identify any other ERP benefits that have not been included in the above list? _____

_____

3) The following factors have been identified as being critical to the success of an ERP implementation and optimisation. Please arrange these factors in what you believe to be the order of importance, with "1" being the most critical factor.

Critical Success Factor	**Order of Importance**
1) Appropriate business & legacy systems management	
2) Business plan, vision & strategy	
3) Business process re-engineering	
4) Change management	
5) Education and training	
6) Effective communication	
7) ERP package selection	
8) ERP team composition	
9) IT infrastructure	
10) Minimum customisation	
11) Performance evaluation	
12) Project management	
13) Software development, testing & troubleshooting	
14) Top management commitment	
15) Additional factor 1:_____	
16) Additional factor 2:_____	
17) Additional factor 3:_____	

Figure B1: Draft interview questionnaire

Pilot Study

Objectives

The main aim of the pilot study was to test the questionnaire in an interview format with a sample of users:

1. To determine if the introduction (interview objectives) section is sufficient for participants to proceed with reviewing the questions.
2. To test if the format and wording of the questions could be easily understood.
3. To determine if any additions were required to the content or format of the questionnaire to enable the interview session to effectively and efficiently extract the required information.
4. To test the time taken to complete the questionnaire.

Methodology

As the interviews target both business users and implementation experts (vendors/consultants) it was felt necessary to test the interview questionnaire at each of these levels. The interview questionnaire was therefore tested via the following process:

1. Two participants (one business user and one ERP consultant/vendor) were identified to take part in the pilot study.
2. The two identified participants were contacted via telephone to explain the purpose of the pilot study and ask for their participation.
3. One hour interview sessions were set up with each participant for an appropriate date and time.
4. During the interview sessions the questionnaire was completed with the participants and observed findings as well as the participants' recommendations were noted.
5. The time for each interview session was recorded.
6. The findings from the interview sessions were reviewed and changes made to the questionnaire where applicable.

Findings

One business user (Business Systems Director) and one ERP consultant (Managing Consultant) took part in the pilot study. The following findings were noted:

1. After receiving the introductory telephone call, the participants both felt that the questionnaire introduction (interview objections) was sufficient for the participants to proceed with reviewing the questions in preparation for the interview sessions.
2. Both participants concurred that the format and wording of the questions was clear and simple to follow.
3. In completing the ERP benefits and CSF tables, many valid comments were made by the participants. In trying to capture all the comments the researcher often ran out of space on the questionnaire form.
4. The two interviews lasted approximately 50 minutes and 55 minutes respectively, during which no interviewee fatigue was observed.
5. On concluding the pilot interviews the participants were asked to comment on ways to improve the interview process. Both commented that they felt it was effective, noting that any questions they had on initially reviewing the questionnaire were clarified in the interview sessions.

Design Changes

Based on the pilot study, the only design change made to the questionnaire was the inclusion of a comments column on the benefits and CSF tables. The final questionnaire design is shown in Figure B2.

ERP BENEFITS AND CSF INTERVIEW

Interview Objectives:

The purpose of this interview is to draw on the interviewee's knowledge of working with ERP systems to determine:

1. The potential ERP benefits that should be expected from implementing an ERP system within a South African manufacturing organisation.
2. The importance of identified Critical Success Factors (CSFs) when implementing an ERP system.

Questions:

1) The following table consists of a list of possible ERP benefits. Please indicate the extent to which you agree that these benefits will result through the introduction of an ERP system to a manufacturing organisation in South Africa.

ERP Benefit	Completely Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Completely Agree	Comments
Financial Benefits								
1) Reduction in operating and admin costs	-3	-2	-1	0	1	2	3	
2) Reduction in stock levels	-3	-2	-1	0	1	2	3	
3) Increased turnover	-3	-2	-1	0	1	2	3	
4) Reduced IT operating costs	-3	-2	-1	0	1	2	3	
5) Reduced quality costs	-3	-2	-1	0	1	2	3	
Internal Business Benefits								
1) Enhanced productivity and efficiencies	-3	-2	-1	0	1	2	3	
2) Improved resource utilization	-3	-2	-1	0	1	2	3	
3) Enhanced business processes	-3	-2	-1	0	1	2	3	
4) Reduced manufacturing cycle times	-3	-2	-1	0	1	2	3	
5) Reduced data processing time	-3	-2	-1	0	1	2	3	
6) Increased inventory turns	-3	-2	-1	0	1	2	3	
7) Improved accuracy and timeliness of information	-3	-2	-1	0	1	2	3	
8) Enhanced internal information sharing	-3	-2	-1	0	1	2	3	
9) Reduced manufacturing lead times	-3	-2	-1	0	1	2	3	
10) Increased integration of applications	-3	-2	-1	0	1	2	3	
11) Improved decision making	-3	-2	-1	0	1	2	3	
12) Improved vendor performance	-3	-2	-1	0	1	2	3	
Customer Benefits								
1) Improved customer service	-3	-2	-1	0	1	2	3	
2) Increased on time shipments	-3	-2	-1	0	1	2	3	
3) Improved quality	-3	-2	-1	0	1	2	3	
4) Improved external information sharing	-3	-2	-1	0	1	2	3	
5) Reduced service lead times	-3	-2	-1	0	1	2	3	
Learning and Growth Benefits								
1) Increased user friendliness of IS	-3	-2	-1	0	1	2	3	
2) Changed work patterns	-3	-2	-1	0	1	2	3	
3) Facilitates organisational learning	-3	-2	-1	0	1	2	3	
4) Empower employees to be more effective	-3	-2	-1	0	1	2	3	
5) Help build a common vision	-3	-2	-1	0	1	2	3	

PG 2

2) Can you identify any other ERP benefits that have not been included in the above list?

_____

_____

3) The following factors have been identified as being critical to the success of an ERP implementation and optimisation. Please arrange these factors in what you believe to be the order of importance, with "1" being the most critical factor.

Critical Success Factor	**Order of Importance**	**Comments**
1) Appropriate business & legacy systems management		
2) Business plan, vision & strategy		
3) Business process re-engineering		
4) Change management		
5) Education and training		
6) Effective communication		
7) ERP package selection		
8) ERP team composition		
9) IT infrastructure		
10) Minimum customisation		
11) Performance evaluation		
12) Project management		
13) Software development, testing & troubleshooting		
14) Top management commitment		
15) Additional factor 1: _____		
16) Additional factor 2: _____		
17) Additional factor 3: _____		

Figure B2: Final interview questionnaire design

APPENDIX C: ABC CLASSIFICATION

The purpose of the benefits section of the interview is to confirm the validity of the benefits identified in the literature and their applicability to the South African environment. Since the literature review classified benefits on an ABC basis, a similar approach is adopted to analyse the interview responses with the goal of linking the literature and interview findings to determine an overall classification, and hence applicability, of a benefit. To achieve this, the following classification rules are applied to the data in Table 4.3:

Central tendency classification

The central tendency is the central point around which the data revolve (Leedy and Ormrod2005, p257). It is classified using the Likert scale from the benefits section of the questionnaire as a guide.

Table C1 ABC classification of central tendency

Classification	Value	Rationale
A	Median>=2.5	Central tendency tends towards "completely agree"
B	1.5=<median<2.5	Central tendency tends towards "mostly agree"
C	median<1.5	Central tendency tends towards "slightly agree"(or less)

Skewness classification

The skewness classification is used to determine the symmetry of the distribution. The more symmetrical (normal) the distribution, the more applicable the standard deviation in measuring the division amongst the responses. Hildebrand (1986) states that when using equation 4.3 (reproduced below):

$$sk = \frac{(mean - median)}{\sigma} \qquad (4.3)$$

an absolute value above 0.2 indicates great skewness, i.e.:

$$\left|\frac{(mean - median)}{\sigma}\right| > 0.2$$

However, for this study equation 4.6 ($sk = |mean - median|$) is used to classify the responses. Equating equation 4.6 to Hildebrand's scale, provides a guide for this study where "great" skewness is shown by:

$$|mean - median| > 0.2\sigma \quad \text{(C1)}$$

Taking the standard deviation for the total data set (1.26) gives "great" skewness at approximately 0.25. This value is used for the skewness classification:

Table C2 ABC classification of skewness

Classification	Value	Rationale
A	Skewness <=0.25	Provides a value of less than 0.2 when applying equation (4.3), using std dev of total data set (1.26).
B	0.25<skewness=<0.5	Results in a value between 0.2 and 0.4 when applying equation 4.3, making std dev less valid
C	Skewness>0.5	Skewness is > twice the recommended level for statistics related to the normal distribution

Variability classification

The standard deviation shows the division (lack of agreement in the responses). The greater the standard deviation, the less agreement. The classification scale is based on the benefits Likert scale and the degree to which the data are spread across the benefits scale.

Table C3 ABC classification of variability

Classification	Value	Rationale
A	Std dev<1	High level of agreement (low spread of data).
B	1=<Std dev<1.5	Moderate level of agreement (medium spread of data).
C	1.5=<Std dev	Low level of agreement (high spread of data).

Applying the above classification process leads to each benefit being defined on a three level basis, i.e. "AAA" to "CCC". However, as the benefits are defined in the literature review on a single level basis (either as "A", "B", or "C"), the interview responses also need to be classified in this manner for an equal

weighting analysis between the literature and interviews to take place. To do this, the following classification rules are applied:

Table C4 Final ERP benefits interview classification

Classification	Rule	Inclusion for classification results*
A	1)The median tends towards completely agree (“A”) and the skewness and variability are low (neither = “C”).	AAA, ABA, ABB
B	1) The median is high (“A”), but there is a high skewness (“C”) and/or variability (“C”). 2) The median tends towards mostly agree (“B”) and skewness is “A” or “B”.	ACB, ACC, BAB, BAC, BBB, BBC, BAA
C	1) The median tends towards mostly agree (“B”), but both skewness and variability are high (“C”). 2) The median is low (“C”).	BCC, CAC

*Classification order: “median”, “skewness”, “standard deviation”

Once the results from the interviews have been classified in this manner, they are compared to the literature findings to determine a final classification for each benefit based on the following rules:

Table C5 Overall ABC classification

Overall “ABC” Classification	Rule	Inclusion
A	1) Literature classification is “A”, and this benefit has been greatly or moderately confirmed by the interview process (“A” or “B”). 2) Literature classification is “B” or “C”, but its applicability is greatly confirmed through the interview process (“A”).	AA, AB, BA, CA
B	1) Moderate support for the benefit has been found when combining the literature and interview data.	BC, BB,CB
C	1) Support for this measure is low both in the literature and the interview data (both are “C”).	CC

The results of the classifications discussed above are shown in Table 4.5.

APPENDIX D: STRUCTURED INTERVIEW TRANSCRIPTS

This section contains the detailed interview transcripts for the interviews held with the individuals in Table D1 (all participants have given permission for their participation to be noted). Each transcript was emailed to the appropriate respondent for validation before consolidating the feedback.

Table D1 Interview participants

Ref	Category	Participant	Company	Position
B1	Business User	Ian Trotter	Nampak	Divisional Business Systems Director
B2	Business User	Calvin De Souza	Nampak	General Manager
B3	Business User	Ronnie Saelens	Nampak	Group Business Systems Manager
B4	Business User	Craig Bryson	Nestle	National Supply and Demand Manager
B5	Business User	Chris Tugman	Colgate Palmolive	IT Director
C1	ERP Consultant	Vis Naidoo	Commerzone	Managing Consultant
C2	ERP Consultant	Robbie Quercia	Deloitte Consulting	ERP Consulting Manager
C3	ERP Consultant	Gerhard Carstens	Barloworld Logistics	General Manager: Supply Chain Engineering
V1	ERP Vendor	Gavin Holme	SAP	Head of Business Consulting
V2	ERP Vendor	Attie Taljaard	Oracle	Head of Applications Sales Consulting

ERP Benefits and CSF Interview (B1 – Ian Trotter)

Questions:

1) The following table consists of a list of possible ERP benefits. Please indicate the extent to which you agree that these benefits will result through the introduction of an ERP system to a manufacturing organisation in South Africa.

ERP Benefit	Completely Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Completely Agree	Comments
Financial Benefits								
1) Reduction in operating and admin costs	-3	-2	-1	0	1	2	~~3~~	
2) Reduction in stock levels	-3	-2	-1	0	1	2	~~3~~	Due mainly to correct use of advanced planning tools.
3) Increased turnover	-3	-2	-1	0	1	2	~~3~~	
4) Reduced IT operating costs	-3	-2	-1	0	~~1~~	2	3	Initial costs could increase. Not a major expected benefit, although depends on previous legacy systems/infrastructure in place.
5) Reduced quality costs	-3	-2	-1	0	1	~~2~~	3	Should not be expected initially, but should result once system is bedded down.
Internal Business Benefits								
1) Enhanced productivity and efficiencies	-3	-2	-1	0	1	2	~~3~~	Due mainly to correct use of advanced planning tools.
2) Improved resource utilization	-3	-2	-1	0	1	~~2~~	3	Applies to both human and machine utilization.
3) Enhanced business processes	-3	-2	-1	0	1	2	~~3~~	Enables companies to establish Standard Operating Practices (SOPs).
4) Reduced manufacturing cycle times	-3	-2	-1	0	1	2	~~3~~	Due mainly to correct use of advanced planning tools.
5) Reduced data processing time	-3	-2	-1	0	1	~~2~~	3	Depends on setup of current vs previous systems.
6) Increased inventory turns	-3	-2	-1	0	1	2	~~3~~	
7) Improved accuracy and timeliness of information	-3	-2	-1	0	~~1~~	2	3	Effort is required on the part of the business/users, and it can often be a long road to achieving this benefit.
8) Enhanced internal information sharing	-3	-2	-1	0	1	2	~~3~~	
9) Reduced manufacturing lead times	-3	-2	-1	0	1	2	~~3~~	Due mainly to correct use of advanced planning tools.
10) Increased integration of applications	-3	-2	-1	0	1	2	~~3~~	Depends on the applications implemented and the "middleware" used.
11) Improved decision making	-3	-2	-1	0	1	~~2~~	3	Depends on how the ERP reporting system is set up to report information - if setup optimally, improved decision making should result.
12) Improved vendor performance	-3	-2	-1	0	1	~~2~~	3	Improved information availability and sharing should enable better vendor management.
Customer Benefits								
1) Improved customer service	-3	-2	-1	0	1	2	~~3~~	
2) Increased on time shipments	-3	-2	-1	0	1	2	~~3~~	
3) Improved quality	-3	-2	-1	0	1	~~2~~	3	As above, only notice improvement with time.
4) Improved external information sharing	-3	-2	-1	0	1	2	~~3~~	Increased availability of information should lead to multiple ways to feedback to customers and satisfy requirements.
5) Reduced service lead times	-3	-2	-1	0	1	2	~~3~~	Due mainly to correct use of advanced planning tools.
Learning and Growth								

Benefits								
1) Increased user friendliness of IS	-3	-2	-1	0	1	~~2~~	3	Benefit exists, but takes time for users to adapt to new system.
2) Changed work patterns	-3	-2	-1	0	1	2	~~3~~	ERP should allow for simplified work patterns, and standard way of working.
3) Facilitates organisational learning	-3	-2	-1	0	1	~~2~~	3	
4) Empower employees to be more effective	-3	-2	-1	0	1	~~2~~	3	Takes time to develop; should be viewed over short, medium and long term.
5) Help build a common vision	-3	-2	-1	0	1	2	~~3~~	Assists in translating vision down to business unit as well as end user level.

2) Can you identify any other ERP benefits that have not been included in the above list?

a) Facilitates oganisational business model changes and business alignment.
b) Common KPIs.

Summary of General Comments on ERP Benefits

a) Many of the benefits mentioned above will only be achieved through the use of the ERP system in conjunction with advanced planning applications.
b) ERP benefits should not be expected to materialise immediately, but should rather be evaluated over the short (6-9months), medium term (9-18) and long term (18months +).

3) The following factors have been identified as being critical to the success of an ERP implementation and optimisation. Please arrange these factors in what you believe to be the order of importance, with "1" being the most critical factor.

Critical Success Factor	**Order of Importance**	**Comments**
1) Appropriate business & legacy systems management	14	
2) Business plan, vision & strategy	4	
3) Business process re-engineering	8	
4) Change management	6	
5) Education and training	5	
6) Effective communication	9	
7) ERP package selection	3	
8) ERP team composition	7	
9) IT infrastructure	13	
10) Minimum customisation	2	
11) Performance evaluation	12	
12) Project management	10	
13) Software development, testing & troubleshooting	11	
14) Top management commitment	1	Should be expanded to include Top Management "Leadership".

ERP Benefits and CSF Interview (B2 – Calvin De Souza)

Questions:

1) The following table consists of a list of possible ERP benefits. Please indicate the extent to which you agree that these benefits will result through the introduction of an ERP system to a manufacturing organisation in South Africa.

ERP Benefit	Completely Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Completely Agree	Comments
Financial Benefits								
1) Reduction in operating and admin costs	-3	-2	-1	0	1	~~2~~	3	Transactional costs can be reduced through ability to set up a shared service/centralised processing team and the like, leading to a reduction in head count etc.
2) Reduction in stock levels	-3	-2	-1	0	1	2	~~3~~	Should result from APS tools (raw materials, WIP and finished goods), but can be limited by business/ supply constraints (e.g. lead times from suppliers).
3) Increased turnover	-3	-2	-1	0	1	~~2~~	3	Agree, but main benefits from cost reduction.
4) Reduced IT operating costs	-3	-2	-1	0	~~1~~	2	3	Initial costs of implementation as well as upgrades are high, but cost benefits at a wider company level could result over time.
5) Reduced quality costs	-3	-2	-1	0	1	~~2~~	3	Possible if quality module is implemented. But could also result from adopting standard operating practices.
Internal Business Benefits								
1) Enhanced productivity and efficiencies	-3	-2	-1	0	1	2	~~3~~	Can be enhanced through better planning (APS tools).
2) Improved resource utilization	-3	-2	-1	0	1	~~2~~	3	Can be enhanced through better planning (APS tools).
3) Enhanced business processes	-3	-2	-1	0	1	~~2~~	3	By adopting best practices associated with the ERP system.
4) Reduced manufacturing cycle times	-3	-2	-1	0	1	~~2~~	3	Should improve through the use of APS tools.
5) Reduced data processing time	-3	-2	-1	0	~~1~~	2	3	Depends on quantity of information being captured prior to the implementation and the amount of manual documentation being used.
6) Increased inventory turns	-3	-2	-1	0	1	~~2~~	3	Should improve with reduced stock levels.
7) Improved accuracy and timeliness of information	-3	-2	-1	0	1	2	~~3~~	Accuracy depends on users' input, but ERP system enables integrity of data to be monitored. Timeliness and availability of information enhanced through reporting (BI) tools (all required parties have access to up to date information).
8) Enhanced internal information sharing	-3	-2	-1	0	1	2	~~3~~	Everybody has access to the same information on a daily basis.
9) Reduced manufacturing lead times	-3	-2	-1	0	1	~~2~~	3	Should come down with APS: improved forecasting and planning.
10) Increased integration of applications	-3	-2	-1	0	1	2	~~3~~	Due to using one system.
11) Improved decision making	-3	-2	-1	0	1	~~2~~	3	Due to greater information availability.
12) Improved vendor performance	-3	-2	-1	0	1	~~2~~	3	By providing better information and collaborating with vendors.

Customer Benefits								
1) Improved customer service	-3	-2	-1	0	1	2	3	Due to improved information to collaborate with customers and use of APS tools. Higher accuracy of documentation, e.g. invoicing.
2) Increased on time shipments	-3	-2	-1	0	1	2	3	Through APS tools (dependant on customer forecast accuracy), and improved overall business system performance.
3) Improved quality	-3	-2	-1	0	1	2	3	If specific quality module installed.
4) Improved external information sharing	-3	-2	-1	0	1	2	3	More useful information available to give to customers.
5) Reduced service lead times	-3	-2	-1	0	1	2	3	Dependant on forecasts etc.
Learning and Growth Benefits								
1) Increased user friendliness of IS	-3	-2	-1	0	1	2	3	Although, most users have to go through a learning curve to adapt to the new system.
2) Changed work patterns	-3	-2	-1	0	1	2	3	Provides more efficient way of working.
3) Facilitates organisational learning	-3	-2	-1	0	1	2	3	Integrated system based on best practice lends itself to improved organisational learning.
4) Empower employees to be more effective	-3	-2	-1	0	1	2	3	Depends on individual and his fit within the company. More information enhances the users' abilities to do their jobs.
5) Help build a common vision	-3	-2	-1	0	1	2	3	ERP system does help, but the vision goes beyond the system

2) Can you identify any other ERP benefits that have not been included in the above list?

A standard set of KPIs linked to the system enhances performance measurement and management. (Allows for consistent measurement of individuals).

Summary of General Comments on ERP Benefits

For benefits to be realised emphasis needs to be placed on the people issues that arise during an ERP implementation and its initial operation.

3) The following factors have been identified as being critical to the success of an ERP implementation and optimisation. Please arrange these factors in what you believe to be the order of importance, with "1" being the most critical factor.

Critical Success Factor	**Order of Importance**	**Comments**
1) Appropriate business & legacy systems management	7	Important to manage and "cleanup" data in legacy systems before cutting over to an ERP system.
2) Business plan, vision & strategy	2	
3) Business process re-engineering	4	
4) Change management	3	
5) Education and training	5	
6) Effective communication	6	
7) ERP package selection	14	Top ERP systems should offer the same functionality.
8) ERP team composition	13	
9) IT infrastructure	9	Need base standard of network/hardware infrastructure in place for ERP to work effectively.
10) Minimum customisation	11	
11) Performance evaluation	10	Need to measure to get benefits – important during optimisation of system.
12) Project management	8	
13) Software development, testing & troubleshooting	12	Should be standard with any implementation.
14) Top management commitment	1	
15) Additional factor 1: User adherence to procedures		

ERP Benefits and CSF Interview (B3 – Ronnie Saelens)

Questions:

1) The following table consists of a list of possible ERP benefits. Please indicate the extent to which you agree that these benefits will result through the introduction of an ERP system to a manufacturing organisation in South Africa.

ERP Benefit	Completely Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Completely Agree	Comments
Financial Benefits								
1) Reduction in operating and admin costs	-3	-2	-1	0	1	2	~~3~~	Due to better processes, guidance, automation of manual process.
2) Reduction in stock levels	-3	-2	-1	0	1	2	~~3~~	Level would be higher if APS applied, but reduction should be achieved if ERP philosophy is followed.
3) Increased turnover	-3	-2	-1	0	1	2	~~3~~	Indirect benefit, due to better customer service enabled through ERP (better documentation, data, and information).
4) Reduced IT operating costs	-3	-2	-1	0	1	2	~~3~~	Depends on base, but should be expected if diverse systems to consolidate. If low level of IT systems in place, costs may increase.
5) Reduced quality costs	~~-3~~	-2	-1	0	1	2	3	Better quality of information to execute against, but product quality determined by factory processes. (Differentiate between the two – see customer benefits.)
Internal Business Benefits								
1) Enhanced productivity and efficiencies	-3	-2	-1	0	1	2	~~3~~	Related to operating and admin costs – direct functions get more efficient and productive, but increased staff skills may be required.
2) Improved resource utilization	-3	-2	-1	0	1	2	~~3~~	APS will optimise further, but following ERP philosophy should enable benefits.
3) Enhanced business processes	-3	-2	-1	0	1	2	~~3~~	Due to best practice, more control, automation and discipline associated with ERP
4) Reduced manufacturing cycle times	-3	-2	-1	0	~~1~~	2	3	More APS and factory floor system related.
5) Reduced data processing time	-3	-2	-1	~~0~~	1	2	3	Enter data once, but more data to enter (one offsets the other).
6) Increased inventory turns	-3	-2	-1	0	1	2	~~3~~	If ERP philosophy applied (e.g. target setting).
7) Improved accuracy and timeliness of information	-3	-2	-1	0	1	2	~~3~~	More focus on data and associated disciplines
8) Enhanced internal information sharing	-3	-2	-1	0	1	2	~~3~~	Due to integration and transparency of information.
9) Reduced manufacturing lead times	-3	-2	-1	0	1	2	~~3~~	
10) Increased integration of applications	-3	-2	-1	0	1	2	~~3~~	Reduce auxiliary systems. Leads to other benefits (e.g. 8) (note level of benefit).
11) Improved decision making	-3	-2	-1	0	1	2	~~3~~	More information to make decisions.

12) Improved vendor performance	-3	-2	-1	0	1	2	3	Depends on procurement maturity and focus (system can act as an enabler).
Customer Benefits								
1) Improved customer service	-3	-2	-1	0	1	2	3	Due to increased information (could include admin quality).
2) Increased on time shipments	-3	-2	-1	0	1	2	3	Due to increased information.
3) Improved quality	-3	-2	-1	0	1	2	3	Affects quality of administration (information, documents etc), but not necessarily product quality.
4) Improved external information sharing	-3	-2	-1	0	1	2	3	
5) Reduced service lead times	-3	-2	-1	0	1	2	3	Should result from following ERP philosophy.
Learning and Growth Benefits								
1) Increased user friendliness of IS	-3	-2	-1	0	1	2	3	More uniformity, but increased friendliness should not be expected (i.e. legacy system often simpler to use).
2) Changed work patterns	-3	-2	-1	0	1	2	3	
3) Facilitates organisational learning	-3	-2	-1	0	1	2	3	More formal courses etc.
4) Empower employees to be more effective	-3	-2	-1	0	1	2	3	Leads to stricter process control, which should increase effectiveness, but could also reduce employee empowerment.
5) Help build a common vision	-3	-2	-1	0	1	2	3	By building common philosophy into work methodology.

2) Can you identify any other ERP benefits that have not been included in the above list?

a) Flexibility – increased ability to make informed decisions to react quickly to customer demand.
b) Execute management philosophy – execute strategy.
c) Assists ease mergers and acquisitions – formal way of exporting way of working.
d) Could benefit share price – market perception if implementation successful (perceived better governance etc).

3) The following factors have been identified as being critical to the success of an ERP implementation and optimisation. Please arrange these factors in what you believe to be the order of importance, with "1" being the most critical factor.

Critical Success Factor	Order of Importance	Comments
1) Appropriate business & legacy systems management	13	
2) Business plan, vision & strategy	2	
3) Business process re-engineering	6	
4) Change management	3	Essential to reduce resistance and help leverage benefit of system and change way of working.
5) Education and training	7	
6) Effective communication	11	
7) ERP package selection	9	
8) ERP team composition	4	
9) IT infrastructure	10	
10) Minimum customisation	12	
11) Performance evaluation	14	
12) Project management	5	
13) Software development, testing & troubleshooting	8	
14) Top management commitment	1	If ownership is not at top level all else will be in vain.

Summary of General Comments

a) Could rate CSFs as high, medium and low as many benefits are linked (e.g. communication and training linked to change management).
b) ERP success is determined more by the people aspect (how people embrace the ERP philosophy) than the technology aspect (e.g. system choice).

ERP Benefits and CSF Interview (B4 – Craig Bryson)

Questions:

1) The following table consists of a list of possible ERP benefits. Please indicate the extent to which you agree that these benefits will result through the introduction of an ERP system to a manufacturing organisation in South Africa.

ERP Benefit	Completely Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Completely Agree	Comments
Financial Benefits								
1) Reduction in operating and admin costs	-3	-2	-1	0	1	2	3	ERP will bring in efficiencies in disciple. Admin costs will probably increase. In certain areas costs may decrease, but in other areas head count may increase (ERP systems are not resource light). The key is to "right size" to match the system requirements.
2) Reduction in stock levels	-3	-2	-1	0	1	2	3	Planning benefit, not ERP benefit (ERP provides basis for better data).
3) Increased turnover	-3	-2	-1	0	1	2	3	Primarily from planning environment and BI tools.
4) Reduced IT operating costs	-3	-2	-1	0	1	2	3	Ability to go to centralised service, but depends on base and IT strategy (if IT strategy not aligned to business, costs could increase).
5) Reduced quality costs	-3	-2	-1	0	1	2	3	Better data and QA visibility.
Internal Business Benefits								
1) Enhanced productivity and efficiencies	-3	-2	-1	0	1	2	3	Forces discipline, but could lose flexibility. In certain situations yes, in others no.
2) Improved resource utilization	-3	-2	-1	0	1	2	3	People – resource intensive. Machines – Advanced Planning benefit not ERP benefit.
3) Enhanced business processes	-3	-2	-1	0	1	2	3	By natural process of implementation, opportunity is created to enhance business processes (but depends on base and flexibility of ERP system).
4) Reduced manufacturing cycle times	-3	-2	-1	0	1	2	3	Function of plant flexibility vs ERP.
5) Reduced data processing time	-3	-2	-1	0	1	2	3	Improved through consolidated environment, but certain process tasks (e.g. introducing a new product) can take longer.
6) Increased inventory turns	-3	-2	-1	0	1	2	3	Planning benefit, not ERP benefit.
7) Improved accuracy and timeliness of information	-3	-2	-1	0	1	2	3	One of the main benefits of going onto an ERP system.
8) Enhanced internal information sharing	-3	-2	-1	0	1	2	3	System supports information sharing (BI tools consolidate information for decision making).
9) Reduced manufacturing lead times	-3	-2	-1	0	1	2	3	Need agile plants, flexible suppliers, etc to reduce manufacturing lead times (ERP system has minor, if any, influence).
10) Increased integration of applications	-3	-2	-1	0	1	2	3	Through consolidating multiple systems into one system with same look and feel.
11) Improved decision making	-3	-2	-1	0	1	2	3	Provides better data for decision-making, i.e. it provides the platform, but the APS tools process the data to enable better decision-making.
12) Improved vendor performance	-3	-2	-1	0	1	2	3	Enables data to be fed back which can influence performance, but depends mainly on the management (often assisted by enabling tools) of the information fed back and used in the measurement process.

Customer Benefits								
1) Improved customer service	-3	-2	-1	0	1	2	3	Influenced by planning systems more than ERP (benefit won't come just from ERP, but rather from the enabling tools as well).
2) Increased on time shipments	-3	-2	-1	0	1	2	3	Helps with accurate inventory and warehouse material handling procedures.
3) Improved quality	-3	-2	-1	0	1	2	3	If there is a focus on quality.
4) Improved external information sharing	-3	-2	-1	0	1	2	3	More about business processes than the ERP system.
5) Reduced service lead times	-3	-2	-1	0	1	2	3	No effect noted.
Learning and Growth Benefits								
1) Increased user friendliness of IS	-3	-2	-1	0	1	2	3	It takes users time to get used to the new system. ERP brings discipline, but not usually user friendliness.
2) Changed work patterns	-3	-2	-1	0	1	2	3	Work patterns are forced to change in line with ERP systems.
3) Facilitates organisational learning	-3	-2	-1	0	1	2	3	Because users are following standard processes, it is easy to implement standard education programmes across the company.
4) Empower employees to be more effective	-3	-2	-1	0	1	2	3	Forces users to follow procedures and not to be flexible. The system supports efficiencies, but not effectiveness.
5) Help build a common vision	-3	-2	-1	0	1	2	3	Activities around implementation help get everyone moving in the same direction.

2) Can you identify any other ERP benefits that have not been included in the above list?

Efficiencies from improved disciplines, good consolidator (platform for better data).

3) The following factors have been identified as being critical to the success of an ERP implementation and optimisation. Please arrange these factors in what you believe to be the order of importance, with "1" being the most critical factor.

Critical Success Factor	Order of Importance	Comments
1) Appropriate business & legacy systems management	12	
2) Business plan, vision & strategy	8	
3) Business process re-engineering	9	
4) Change management	2	
5) Education and training	4	
6) Effective communication	3	
7) ERP package selection	14	Most systems are very similar in functionality.
8) ERP team composition	10	
9) IT infrastructure	13	Should be related to IT strategy and what the vendor recommends.
10) Minimum customisation	6	Has impact on upgrades etc.
11) Performance evaluation	11	
12) Project management	5	
13) Software development, testing & troubleshooting	7	
14) Top management commitment	1	Need strong buy in and push into the business.

Summary of General Comments

a) Implementation should be about people first and functionality second.
b) Many of the benefits listed are related more to APS or decision support tools.
c) ERP supports efficiencies rather than effectiveness.

ERP Benefits and CSF Interview (B5 – Chris Tugman)

Questions:

1) The following table consists of a list of possible ERP benefits. Please indicate the extent to which you agree that these benefits will result through the introduction of an ERP system to a manufacturing organisation in South Africa.

ERP Benefit	Completely Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Completely Agree	Comments
Financial Benefits								
1) Reduction in operating and admin costs	-3	-2	-1	0	1	~~2~~	3	Cost of support of ERP should reduce compared to legacy system.
2) Reduction in stock levels	-3	-2	-1	~~0~~	1	2	3	
3) Increased turnover	-3	-2	-1	~~0~~	1	2	3	Depends on legacy system in place.
4) Reduced IT operating costs	-3	-2	-1	0	1	2	~~3~~	Due to standardization and centralization.
5) Reduced quality costs	-3	-2	-1	~~0~~	1	2	3	Depends on ERP vs legacy system (many companies stay away from quality modules).
Internal Business Benefits								
1) Enhanced productivity and efficiencies	-3	-2	-1	0	1	~~2~~	3	People know that the system works, reducing the need for multiple checks etc.
2) Improved resource utilization	-3	-2	-1	0	1	2	~~3~~	Specifically around replacing skills/experts, and managing hardware utilization.
3) Enhanced business processes	-3	-2	-1	0	1	2	~~3~~	Due to intelligence built into ERP system, vs archaic controls within legacy systems.
4) Reduced manufacturing cycle times	-3	-2	-1	~~0~~	1	2	3	Depends on how ERP vs legacy system is utilized.
5) Reduced data processing time	-3	-2	-1	~~0~~	1	2	3	
6) Increased inventory turns	-3	-2	-1	0	~~1~~	2	3	Depends on how efficiently system is used.
7) Improved accuracy and timeliness of information	-3	-2	-1	0	1	2	~~3~~	ERP systems have inherent level of accuracy that legacy systems don't have.
8) Enhanced internal information sharing	-3	-2	-1	0	1	2	~~3~~	Access to same information at corporate level as at plant level.
9) Reduced manufacturing lead times	-3	-2	-1	~~0~~	1	2	3	Dependant on many external factors not necessarily driven by the system.
10) Increased integration of applications	-3	-2	-1	0	1	2	~~3~~	Inherent level of integrity of system integration.
11) Improved decision making	-3	-2	-1	0	~~1~~	2	3	Depends on BI systems previously bolted onto legacy system.
12) Improved vendor performance	-3	-2	-1	0	1	2	~~3~~	Especially through vendor managed inventory which requires standardization.
Customer Benefits								
1) Improved customer service	-3	-2	-1	~~0~~	1	2	3	Depends on base.
2) Increased on time shipments	-3	-2	-1	~~0~~	1	2	3	Depends on base.
3) Improved quality	-3	-2	-1	~~0~~	1	2	3	Depends on base.
4) Improved external information sharing	-3	-2	-1	0	1	2	~~3~~	Ability to interface with other (customer) systems.
5) Reduced service lead times	-3	-2	-1	~~0~~	1	2	3	Depends on base.
Learning and Growth Benefits								
1) Increased user friendliness of IS	-3	-2	-1	0	1	2	~~3~~	People are specifically ERP trained vs difficulty with training of customised legacy systems.
2) Changed work patterns	-3	-2	-1	0	1	2	~~3~~	Adoption of standard work patterns.

3) Facilitates organisational learning	-3	-2	-1	0	1	~~2~~	3	
4) Empower employees to be more effective	-3	-2	-1	0	~~1~~	2	3	Should benefit, but depends on extent to which legacy system was utilized.
5) Help build a common vision	-3	-2	-1	0	1	2	~~3~~	Helps facilitate one company wide strategy.

2) Can you identify any other ERP benefits that have not been included in the above list?

Creating focus within the company.

3) The following factors have been identified as being critical to the success of an ERP implementation and optimisation. Please arrange these factors in what you believe to be the order of importance, with "1" being the most critical factor.

Critical Success Factor	**Order of Importance**	**Comments**
1) Appropriate business & legacy systems management	12	
2) Business plan, vision & strategy	1	Can't have IT strategy until business strategy is clearly defined and understood.
3) Business process re-engineering	13	Align to ERP system (based on world class practices).
4) Change management	3	
5) Education and training	8	
6) Effective communication	7	
7) ERP package selection	5	SAP the clear leader.
8) ERP team composition	4	Need right level of business users.
9) IT infrastructure	6	
10) Minimum customisation	11	
11) Performance evaluation	14	
12) Project management	9	
13) Software development, testing & troubleshooting	11	Specifically end user testing.
14) Top management commitment	2	Ties into business strategy.

ERP Benefits and CSF Interview (C1 – Vis Naidoo)

Questions:

1) The following table consists of a list of possible ERP benefits. Please indicate the extent to which you agree that these benefits will result through the introduction of an ERP system to a manufacturing organisation in South Africa.

ERP Benefit	Completely Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Completely Agree	Comments
Financial Benefits								
1) Reduction in operating and admin costs	-3	-2	-1	0	1	2	~~3~~	Main objective of implementation is to get cost saving benefit.
2) Reduction in stock levels	-3	-2	-1	0	1	2	~~3~~	Ability to control, can gain further benefits with APS.
3) Increased turnover	-3	-2	-1	0	1	~~2~~	3	ERP in combination with APS. Through planning and scheduling, can manufacture correct stock and therefore sell more.
4) Reduced IT operating costs	-3	-2	-1	0	1	~~2~~	3	On one system – not maintaining multiple systems
5) Reduced quality costs	-3	-2	-1	0	~~1~~	2	3	Can get better data, but quality systems sit largely outside ERP.
Internal Business Benefits								
1) Enhanced productivity and efficiencies	-3	-2	-1	0	1	2	~~3~~	Due to better inter-departmental communication and visibility of data.
2) Improved resource utilization	-3	-2	-1	0	1	2	~~3~~	Especially on machine utilization, advanced planning systems can further benefit.
3) Enhanced business processes	-3	-2	-1	0	1	~~2~~	3	Base new system of best practice (refine processes through implementation).
4) Reduced manufacturing cycle times	-3	-2	-1	0	1	~~2~~	3	Due to better access to information.
5) Reduced data processing time	-3	-2	-1	0	1	2	~~3~~	Single point of entry.
6) Increased inventory turns	-3	-2	-1	0	1	2	~~3~~	Sales, manufacturing cycle etc will reduce leading to increased inventory turns.
7) Improved accuracy and timeliness of information	-3	-2	-1	0	1	2	~~3~~	One of main reasons for implementing ERP (to get real time information to make decisions).
8) Enhanced internal information sharing	-3	-2	-1	0	1	2	~~3~~	Empowers people to extract information themselves (not reliant on others).
9) Reduced manufacturing lead times	-3	-2	-1	0	1	2	~~3~~	Due to better planning (APS).
10) Increased integration of applications	-3	-2	-1	0	1	2	~~3~~	Integral to any ERP system.
11) Improved decision making	-3	-2	-1	0	1	2	~~3~~	Access to info to do scenario planning etc.
12) Improved vendor performance	-3	-2	-1	0	1	~~2~~	3	Can manage suppliers (e.g. OTIF) better should lead to increased supplier performance.
Customer Benefits								
1) Improved customer service	-3	-2	-1	0	1	2	~~3~~	Ability to feed back information to customers, and make accurate commitments on deliveries etc.
2) Increased on time shipments	-3	-2	-1	0	1	2	~~3~~	
3) Improved quality	-3	-2	-1	0	1	~~2~~	3	Can manage better, but won't impact directly –down more to production line.
4) Improved external information sharing	-3	-2	-1	0	1	2	~~3~~	Confidence in information increases willingness to collaborate with customers (collaborative planning).
5) Reduced service lead times	-3	-2	-1	0	1	2	~~3~~	Due to collaboration using ERP data.

Learning and Growth Benefits								
1) Increased user friendliness of IS	-3	-2	-1	0	1	2	3	Depends on complexity of ERP system chosen, users adapt over time.
2) Changed work patterns	-3	-2	-1	0	1	2	3	ERP changes work processes, causing people to work more effectively and efficiently.
3) Facilitates organisational learning	-3	-2	-1	0	1	2	3	ERP creates opportunity to grow organisational knowledge (but depends on peoples' ability to change).
4) Empower employees to be more effective	-3	-2	-1	0	1	2	3	More info and automation of data allows people to grow their roles and develop.
5) Help build a common vision	-3	-2	-1	0	1	2	3	ERP combined with good change management can assist build a common vision.

2) Can you identify any other ERP benefits that have not been included in the above list?

a) Standardisation of information.

b) Better business intelligence.

c) Better control of authorization (e.g. around procurement).

d) History to do better forecasting.

3) The following factors have been identified as being critical to the success of an ERP implementation and optimisation. Please arrange these factors in what you believe to be the order of importance, with "1" being the most critical factor.

Critical Success Factor	Order of Importance	Comments
1) Appropriate business & legacy systems management	10	
2) Business plan, vision & strategy	7	Need solid business plan of why implementation is taking place (vision and strategy linked to plan).
3) Business process re-engineering	5	ERP should be used to re-engineer the processes (best practice).
4) Change management	1	People need to accept the system to use it effectively.
5) Education and training	4	
6) Effective communication	2	People need to know what is happening and why it is happening to get on board.
7) ERP package selection	13	Depends on budget, most top ERP systems are very similar – it is more the implementation than the system that leads to success.
8) ERP team composition	8	Need to recruit right people at right price.
9) IT infrastructure	9	Need to align to ERP requirements to ensure users can work effectively.
10) Minimum customisation	14	Customisation will occur to a certain extent, but it needs to be managed.
11) Performance evaluation	12	
12) Project management	11	Still very critical (could be rated higher).
13) Software development, testing & troubleshooting	6	ERP must be linked to best practice to be effective.
14) Top management commitment	3	Important at both head office and plant level.
15) Additional factor 1: Timing of the ERP project	(7.5)	Depends on business readiness.

Summary of General Comments

a) People most important factor - ERP system is used as an enabler to drive the business.

ERP Benefits and CSF Interview (C2 – Robbie Quercia)

Questions:

1) The following table consists of a list of possible ERP benefits. Please indicate the extent to which you agree that these benefits will result through the introduction of an ERP system to a manufacturing organisation in South Africa.

ERP Benefit	Completely Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Completely Agree	Comments
Financial Benefits								
1) Reduction in operating and admin costs	-3	-2	-1	0	1	2	~~3~~	One of the main benefits, but depends on the base line from which the company is coming.
2) Reduction in stock levels	-3	-2	-1	0	1	~~2~~	3	Time based, needs maturity and belief in information to develop. Two tiers – 1st :direct benefit from ERP (assuming data quality), 2nd level from advanced planning tools.
3) Increased turnover	-3	-2	-1	0	1	~~2~~	3	Over medium to long term due to increased understanding of business from the data (i.e. understand customer profitability and create focus).
4) Reduced IT operating costs	-3	-2	~~-1~~	0	1	2	3	Medium term IT costs are driven up.
5) Reduced quality costs	-3	-2	-1	0	~~1~~	2	3	Only if specific quality focus (e.g. in pharmaceutical industries).
Internal Business Benefits								
1) Enhanced productivity and efficiencies	-3	-2	-1	0	1	2	~~3~~	Due largely to visibility of what the business process is.
2) Improved resource utilization	-3	-2	-1	0	1	~~2~~	3	Direct benefit from ERP can be expected, but 2nd tier benefits from enabling software (e.g. production scheduling).
3) Enhanced business processes	-3	-2	-1	0	1	2	~~3~~	Provides opportunity to develop business processes.
4) Reduced manufacturing cycle times	-3	-2	-1	0	1	~~2~~	3	Additional software (e.g. advanced planning) required to get full benefits.
5) Reduced data processing time	-3	-2	-1	~~0~~	1	2	3	Can be expected in some areas (e.g. finance), but not in others (e.g. order management).
6) Increased inventory turns	-3	-2	-1	0	1	~~2~~	3	Due to increased data transparency and reporting, but requires specific focus.
7) Improved accuracy and timeliness of information	-3	-2	-1	0	~~1~~	2	3	Due to data quality, that is people, not system, dependent.
8) Enhanced internal information sharing	-3	-2	-1	0	1	2	~~3~~	The integrated nature and reporting capabilities of the solution encourages this benefit.
9) Reduced manufacturing lead times	-3	-2	-1	0	1	~~2~~	3	Possible if strong manufacturing model implemented.
10) Increased integration of applications	-3	-2	-1	0	1	2	~~3~~	Once benefit noted, businesses are often motivated to strive for further integration with additional enabling systems.
11) Improved decision making	-3	-2	-1	0	1	2	~~3~~	Improved info.
12) Improved vendor performance	-3	-2	-1	0	1	~~2~~	3	Depends on how the information is shared with the suppliers (e.g. more accurate forecasts).
Customer Benefits								
1) Improved customer service	-3	-2	-1	0	1	~~2~~	3	Depends on people discipline and data accuracy.
2) Increased on time shipments	-3	-2	-1	0	1	2	~~3~~	ERP will help, but decision support software will make the real difference.
3) Improved quality	-3	-2	-1	0	~~1~~	2	3	

4) Improved external information sharing	-3	-2	-1	0	1	2	3	Same as vendor performance point, information is there, but depends on processes around sharing the data (e.g. Sales & Operations Planning process).
5) Reduced service lead times	-3	-2	-1	0	1	2	3	Need decision support tools to get the targeted reduction in lead times.
Learning and Growth Benefits								
1) Increased user friendliness of IS	-3	-2	-1	0	1	2	3	Generally more complicated for users initially (improves with time).
2) Changed work patterns	-3	-2	-1	0	1	2	3	ERP enforces best practice.
3) Facilitates organisational learning	-3	-2	-1	0	1	2	3	ERP focuses on process, but not learning. If the implementation process is done correctly learning will occur, but not direct result from ERP.
4) Empower employees to be more effective	-3	-2	-1	0	1	2	3	Due to transparency of data.
5) Help build a common vision	-3	-2	-1	0	1	2	3	ERP can facilitate, but it's the strategy and communication processes that build the common vision.

2) Can you identify any other ERP benefits that have not been included in the above list?

Main benefits have been included.

3) The following factors have been identified as being critical to the success of an ERP implementation and optimisation. Please arrange these factors in what you believe to be the order of importance, with "1" being the most critical factor.

Critical Success Factor	Order of Importance	Comments
1) Appropriate business & legacy systems management	14	
2) Business plan, vision & strategy	2	Aligned with Top management commitment.
3) Business process re-engineering	3	Need to re-engineer to get benefits.
4) Change management	4	Transformation is imperative for success.
5) Education and training	5	
6) Effective communication	7	
7) ERP package selection	12	Top tier vendors are so similar in the ERP offering that it comes down largely to cost rather than functionality.
8) ERP team composition	8	
9) IT infrastructure	13	
10) Minimum customisation	10	With best intentions some customisation will be necessary, but it should be minimised as far as possible.
11) Performance evaluation	9	
12) Project management	6	Issue resolution and escalation process is critical.
13) Software development, testing & troubleshooting	11	Critical, but part of standard process.
14) Top management commitment	1	If top management isn't committed, it doesn't get done.

Summary of General Comments

a) Least important CSFs are around technical points (this is largely a formality).

ERP Benefits and CSF Interview (C3 – Gerhard Carstens)

Questions:

1) The following table consists of a list of possible ERP benefits. Please indicate the extent to which you agree that these benefits will result through the introduction of an ERP system to a manufacturing organisation in South Africa.

ERP Benefit	Completely Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Completely Agree	Comments
Financial Benefits								
1) Reduction in operating and admin costs	-3	-2	-1	0	1	2	~~3~~	Due to automation of activities operating and admin costs should be reduced, however this depends on the setup of the system (e.g. focus on cost accounting may distract from full benefits being achieved).
2) Reduction in stock levels	-3	-2	-1	0	~~1~~	2	3	Puts focus on stock to enable analyses to be down, but will not have a direct impact on reducing stocks.
3) Increased turnover	-3	-2	-1	0	~~1~~	2	3	Depends how information is used to increase sales.
4) Reduced IT operating costs	-3	~~-2~~	-1	0	1	2	3	Investment in infrastructure and addition IT support staff will in all likelihood increase overall IT costs.
5) Reduced quality costs	-3	-2	-1	0	~~1~~	2	3	Assists with getting information to support quality systems, but will not have a direct impact.
Internal Business Benefits								
1) Enhanced productivity and efficiencies	-3	-2	-1	0	~~1~~	2	3	Depends on setup (requires MRP/MPS etc).
2) Improved resource utilization	-3	-2	-1	0	~~1~~	2	3	Depends on having additional systems e.g. APS or BI reporting system, to provide useful information from the data.
3) Enhanced business processes	-3	-2	-1	0	1	~~2~~	3	Direct benefit of ERP if implemented corrected.
4) Reduced manufacturing cycle times	-3	-2	-1	0	~~1~~	2	3	Depends on MPS and APS modules.
5) Reduced data processing time	-3	-2	-1	0	1	~~2~~	3	Improves reporting of financial figures, but may increase certain data capturing activities due to the amount of info to be captured (e.g. BOMs/routings etc).
6) Increased inventory turns	-3	-2	-1	0	~~1~~	2	3	Depends on how information is used.
7) Improved accuracy and timeliness of information	-3	-2	~~-1~~	0	1	2	3	Depends on the users' input and not on the system that is used.
8) Enhanced internal information sharing	-3	-2	-1	0	1	~~2~~	3	Depends on having a BI type layer on top of the ERP system to "enforce" common information sharing (everyone looking at the same reports).
9) Reduced manufacturing lead times	-3	-2	-1	0	~~1~~	2	3	Depends on APS.
10) Increased integration of applications	-3	-2	-1	0	1	~~2~~	3	If managed as central system.
11) Improved decision making	-3	-2	~~-1~~	0	1	2	3	Depends on the users and how they interpret the information (poor decisions can still be made with improved information). Additional tools will be needed to ensure that this benefit is achieved.
12) Improved vendor performance	-3	-2	-1	0	~~1~~	2	3	ERP places focus on vendor performance ensuring that the vendor complies with certain procedures.

Customer Benefits								
1) Improved customer service	-3	-2	-1	0	1	2	3	System can assist with immediate benefits as activities become procedural and formalised.
2) Increased on time shipments	-3	-2	-1	0	1	2	3	Need BI or APS systems, as OTIF direct benefit from planning.
3) Improved quality	-3	-2	-1	0	1	2	3	Depends on information usage.
4) Improved external information sharing	-3	-2	-1	0	1	2	3	Dependant on what you extract from the system (i.e. the systems linked to the ERP system to provide the necessary collaborative information).
5) Reduced service lead times	-3	-2	-1	0	1	2	3	Depends more on planning systems.
Learning and Growth Benefits								
1) Increased user friendliness of IS	-3	-2	-1	0	1	2	3	Can complicate depending on base from which business is moving.
2) Changed work patterns	-3	-2	-1	0	1	2	3	Users are required to work in line with ERP system.
3) Facilitates organisational learning	-3	-2	-1	0	1	2	3	Through the implementation information gets shared amongst role players.
4) Empower employees to be more effective	-3	-2	-1	0	1	2	3	But depends on situation and calibre of users.
5) Help build a common vision	-3	-2	-1	0	1	2	3	A system can assist, but additional efforts are required from the business to create a common vision.

2) Can you identify any other ERP benefits that have not been included in the above list?

Visibility of information (users have more information available to perform their jobs).

Summary of General Comments on ERP Benefits

The ERP system itself is not an enabler, it is the way that you set it up and the way that you use it that will determine the benefits.

3) The following factors have been identified as being critical to the success of an ERP implementation and optimisation. Please arrange these factors in what you believe to be the order of importance, with "1" being the most critical factor.

Critical Success Factor	Order of Importance	Comments
1) Appropriate business & legacy systems management	13	
2) Business plan, vision & strategy	2	If correct vision is not there, the resulting processes and change management will not yield the required benefits.
3) Business process re-engineering	3	
4) Change management	4	
5) Education and training	9	
6) Effective communication	8	
7) ERP package selection	10	
8) ERP team composition	7	Need people who understand the business as well as those who can see the required change that is required.
9) IT infrastructure	12	
10) Minimum customisation	14	
11) Performance evaluation	6	Flows out of vision/strategy and business systems.
12) Project management	5	
13) Software development, testing & troubleshooting	11	
14) Top management commitment	1	

Summary of General Comments

CSFs order of importance can be grouped as follows:

a) Most important: Vision, strategy and processes.

b) Followed by: People aspects (i.e. project team and management, together with change management).

c) Lastly: Technical aspects (i.e. if the correct strategy and people are in place this will ensure that the package selection and set-up are performed correctly).

ERP Benefits and CSF Interview (V1 – Gavin Holme)

Questions:

1) The following table consists of a list of possible ERP benefits. Please indicate the extent to which you agree that these benefits will result through the introduction of an ERP system to a manufacturing organisation in South Africa.

ERP Benefit	Completely Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Completely Agree	Comments
Financial Benefits								
1) Reduction in operating and admin costs	-3	-2	-1	0	1	~~2~~	3	Depends on the business environment. Enables business to become more efficient and grow without increasing head count.
2) Reduction in stock levels	-3	-2	-1	~~0~~	1	2	3	Expectation from advanced planning tools, giving better supply chain visibility, enabling JIT manufacturing.
3) Increased turnover	-3	-2	-1	0	1	~~2~~	3	2005 SAP release more service focused, but need enabling tools such as CRM to get full benefits.
4) Reduced IT operating costs	-3	-2	-1	0	1	2	~~3~~	Reduce infrastructure costs (single platform), reduce licensing costs (one vendor), reduce range of IT skills required (focused skill set).
5) Reduced quality costs	-3	-2	-1	~~0~~	1	2	3	ERP needs to work in conjunction with MES system to get benefit (i.e. APO linked to MES).
Internal Business Benefits								
1) Enhanced productivity and efficiencies	-3	-2	-1	0	1	~~2~~	3	Linked to plant maintenance module, providing earlier visibility and increased up time.
2) Improved resource utilization	-3	-2	-1	0	1	~~2~~	3	With regards to both from machine and human resources.
3) Enhanced business processes	-3	-2	-1	0	1	2	~~3~~	Standardisation of business process, providing commonality, leading to increased efficiencies.
4) Reduced manufacturing cycle times	-3	-2	-1	0	~~1~~	2	3	Reliant on MES solution.
5) Reduced data processing time	-3	-2	-1	0	1	~~2~~	3	Single point on entry etc.
6) Increased inventory turns	-3	-2	-1	0	~~1~~	2	3	Dependant on APO and MES systems.
7) Improved accuracy and timeliness of information	-3	-2	-1	0	1	2	~~3~~	One solution, single source of info, with enhanced reporting capabilities.
8) Enhanced internal information sharing	-3	-2	-1	0	1	2	~~3~~	One version of the truth.
9) Reduced manufacturing lead times	-3	-2	-1	0	1	~~2~~	3	Can do more with APO, linked to CRM.
10) Increased integration of applications	-3	-2	-1	0	1	2	~~3~~	Especially with new strategic direction of SAP.
11) Improved decision making	-3	-2	-1	0	1	~~2~~	3	ERP will give enhanced reporting leading to ability to make decisions. Need analytics associated with reporting to understand trends etc (i.e. BI would be a pre-requisite).
12) Improved vendor performance	-3	-2	-1	0	1	~~2~~	3	Need APO or SRM to get the full benefit.
Customer Benefits								
1) Improved customer service	-3	-2	-1	0	1	~~2~~	3	Can take further with CRM.
2) Increased on time shipments	-3	-2	-1	0	1	~~2~~	3	ERP will improve awareness enabling bottlenecks to be identified and focus to be placed on OT shipments.

3) Improved quality	-3	-2	-1	0	1	2	3	Quality Management module will help understanding of where defects may be.
4) Improved external information sharing	-3	-2	-1	0	1	2	3	The assimilation of information is made a lot easier.
5) Reduced service lead times	-3	-2	-1	0	1	2	3	Due to integration of modules etc.
Learning and Growth Benefits								
1) Increased user friendliness of IS	-3	-2	-1	0	1	2	3	ERP system is more standard, more focused (enabling users to be up skilled in one system). New version allows users to consume SAP in a manner that is relevant to their specific roles.
2) Changed work patterns	-3	-2	-1	0	1	2	3	Benefit due to standardisation.
3) Facilitates organisational learning	-3	-2	-1	0	1	2	3	Economies of scale in terms of one way of training users.
4) Empower employees to be more effective	-3	-2	-1	0	1	2	3	ERP provides ability to transfer process activities to people who are performing the tasks.
5) Help build a common vision	-3	-2	-1	0	1	2	3	Helps roll out the vision, i.e. it is an enabler, not a driver (will not help define the strategy).

2) Can you identify any other ERP benefits that have not been included in the above list?

Main benefits included (SAP presentation on ERP benefits provided for additional information).

3) The following factors have been identified as being critical to the success of an ERP implementation and optimisation. Please arrange these factors in what you believe to be the order of importance, with "1" being the most critical factor.

Critical Success Factor	Order of Importance	Comments
1) Appropriate business & legacy systems management	4	Ensure master data is in order.
2) Business plan, vision & strategy	1	
3) Business process re-engineering	5	
4) Change management	10	
5) Education and training	7	
6) Effective communication	11	
7) ERP package selection	9	Need renowned package/solution to ensure ongoing support etc.
8) ERP team composition	8	
9) IT infrastructure	15	
10) Minimum customisation	6	
11) Performance evaluation	14	
12) Project management	13	Must include benefits tracking.
13) Software development, testing & troubleshooting	12	
14) Top management commitment	2	Need up front.
15) Additional factor 1: Solution design (architecture)	3	Need to define solution, i.e. understand how ERP architecture fits in with IT infrastructure/strategy.

ERP Benefits and CSF Interview (V2 – Attie Taljaard))

Questions:

1) The following table consists of a list of possible ERP benefits. Please indicate the extent to which you agree that these benefits will result through the introduction of an ERP system to a manufacturing organisation in South Africa.

ERP Benefit	Completely Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Completely Agree	Comments
Financial Benefits								
1) Reduction in operating and admin costs	-3	-2	-1	0	1	2	3	Due to standardization, reduction in number of systems (and support/admin staff) and adopting standard operating procedures.
2) Reduction in stock levels	-3	-2	-1	0	1	2	3	
3) Increased turnover	-3	-2	-1	0	1	2	3	Not directly from ERP, more from enabling tools e.g. CRM.
4) Reduced IT operating costs	-3	-2	-1	0	1	2	3	Depends on kind of company (i.e. size/industry).
5) Reduced quality costs	-3	-2	-1	0	1	2	3	Depends on customer objectives and governance issues around products. Also depends on mindset of implementation, i.e. if driven by production vs financial focus.
Internal Business Benefits								
1) Enhanced productivity and efficiencies	-3	-2	-1	0	1	2	3	Depends on base from which the company is coming. Ability to quantify and measure.
2) Improved resource utilization	-3	-2	-1	0	1	2	3	
3) Enhanced business processes	-3	-2	-1	0	1	2	3	Enhanced through leading practice (fitting the business to the system), and identifying areas where most benefit can be achieved.
4) Reduced manufacturing cycle times	-3	-2	-1	0	1	2	3	Depends on models implemented. There must be a manufacturing focus, e.g. focus on lean manufacturing. Additional benefits can be achieved when used in combination with enabling tools (advanced planning).
5) Reduced data processing time	-3	-2	-1	0	1	2	3	Single source of information (single point of truth).
6) Increased inventory turns	-3	-2	-1	0	1	2	3	Depends on base – if coming from low base benefit is definitely possible.
7) Improved accuracy and timeliness of information	-3	-2	-1	0	1	2	3	Creates ability to act earlier, and make informed decisions on timely information.
8) Enhanced internal information sharing	-3	-2	-1	0	1	2	3	
9) Reduced manufacturing lead times	-3	-2	-1	0	1	2	3	
10) Increased integration of applications	-3	-2	-1	0	1	2	3	Single source of truth.
11) Improved decision making	-3	-2	-1	0	1	2	3	Depends on access given to users/managers to make decisions.
12) Improved vendor performance	-3	-2	-1	0	1	2	3	Enables KPIs to be set up and processes to better manage suppliers and SLAs. Again, needs to be a goal at the outset.

Customer Benefits								
1) Improved customer service	-3	-2	-1	0	1	2	3	Better information to understand and manage customers. ERP enables customers to be modelled better.
2) Increased on time shipments	-3	-2	-1	0	1	2	3	
3) Improved quality	-3	-2	-1	0	1	2	3	If quality is a goal.
4) Improved external information sharing	-3	-2	-1	0	1	2	3	Often only comes in Phase 2/3. If focused on earlier (e.g. self service) more benefit would be achieved. (Not often seen to happen, due to fear of security etc.)
5) Reduced service lead times	-3	-2	-1	0	1	2	3	Due to more info being available (e.g. sales history and future demand) enables better decisions to be made going forward.
Learning and Growth Benefits								
1) Increased user friendliness of IS	-3	-2	-1	0	1	2	3	Users often find the system more complex, i.e. ERP may require more data to be entered: users often may not know why this extra info is required. If users have the understanding around what they are doing the system is perceived as being user friendly.
2) Changed work patterns	-3	-2	-1	0	1	2	3	Determined by change management, resistance can often be expected here if not managed effectively. Needs to be managed and incentivised.
3) Facilitates organisational learning	-3	-2	-1	0	1	2	3	ERP can facilitate, but it depends on organisation maturity and the guidance of a steering committee and change management to be effective.
4) Empower employees to be more effective	-3	-2	-1	0	1	2	3	
5) Help build a common vision	-3	-2	-1	0	1	2	3	

2) Can you identify any other ERP benefits that have not been included in the above list?

All main benefits covered above.

3) The following factors have been identified as being critical to the success of an ERP implementation and optimisation. Please arrange these factors in what you believe to be the order of importance, with "1" being the most critical factor.

Critical Success Factor	Order of Importance	Comments
1) Appropriate business & legacy systems management	14	
2) Business plan, vision & strategy	10	
3) Business process re-engineering	8	
4) Change management	2	
5) Education and training	5	
6) Effective communication	3	
7) ERP package selection	13	Differentiation occurs more around the enabling tools that integrate with the ERP system.
8) ERP team composition	7	ERP team must be respected and have the ability to cause change within the business.
9) IT infrastructure	11	
10) Minimum customisation	6	Need to evaluate whether the cost to each customisation is justified. Good governance is required (is it the right business decision?).
11) Performance evaluation	9	Need to measure why things are being done.
12) Project management	4	Important as it sets out objectives, aligned to strategy.
13) Software development, testing & troubleshooting	12	
14) Top management commitment	1	Combined with effective communication plan and change management programme will ensure a successful implementation.

Summary of General Comments

a) Benefits depend largely on organisational maturity and the base from which the organisation is coming.
Advice: measure IT maturity when conducting the market research.

b) CSF importance – people and processes first, technology second.

APPENDIX E: CONSOLIDATED INTERVIEW RESPONSES

The following business users and ERP experts participated in the structured interviews (all have given permission for their participation to be noted):

Table E1 Structured interview participants

Ref	Category	Participant	Company	Position
B1	Business User	Ian Trotter	Nampak	Divisional Business Systems Director
B2	Business User	Calvin De Souza	Nampak	General Manager
B3	Business User	Ronnie Saelens	Nampak	Group Business Systems Manager
B4	Business User	Craig Bryson	Nestle	National Supply and Demand Manager
B5	Business User	Chris Tugman	Colgate Palmolive	IT Director
C1	ERP Consultant	Vis Naidoo	Commerzone	Managing Consultant
C2	ERP Consultant	Robbie Quercia	Deloitte Consulting	ERP Consulting Manager
C3	ERP Consultant	Gerhard Carstens	Barloworld Logistics	General Manager: Supply Chain Engineering
V1	ERP Vendor	Gavin Holme	SAP	Head of Business Consulting
V2	ERP Vendor	Attie Taljaard	Oracle	Head of Applications Sales Consulting

This section summarises the comments that were made by these participants in response to the interview questions. The responses have been summarised on the following tables:

Table E2 contains the responses to the benefits section of the interviews (a paraphrased summary of all responses is provided for each benefit after the individual responses).

Table E3 shows the additional benefits that were suggested by the participants. The second column indicates if the additional benefits can be included under the descriptions of benefits identified in the literature review.

Table E4 details the additional CSFs suggested by the participants.

Table E5 lists the general comments made by the participants regarding the nature and direction of the research.

Note: The complete interview scripts are contained in Appendix D: Structured Interview Transcripts.

Table E2 Participant comments on ERP benefits

Financial Benefits
1) Reduction in operating and admin costs
V1) Depends on the business environment. Enables business to become more efficient and grow without increasing head count.
V2) Due to standardization, reduction in number of systems (and support/admin staff) and adopting std operating procedures.
C1) Main objective of implementation is to get cost saving benefit.
C2) One of the main benefits, but depends on the base line from which the company is coming.
C3) Due to automation of activities operating and admin costs should be reduced, however this depends on the setup of the system (e.g. focus on cost accounting may distract from full benefits being achieved).
B2) Transactional costs can be reduced through ability to set up a shared service/centralised processing team and the like, leading to a reduction in head count etc.
B3) Due to better processes, guidance, automation of manual process.
B4) ERP will bring in efficiencies in discipline. Admin costs will probably increase. In certain areas costs may decrease, but in other areas head count may increase (ERP systems are not resource light). The key is to "right size" to match the system requirements.
B5) Cost of support of ERP should reduce compared to legacy system.
Summary:
Overall the consensus is that if the implementation is done correctly then costs should decrease. This could be due to a number of factors, e.g. better processes, automation of activities, reduction in number of systems, and ability to grow without increasing head count.
2) Reduction in stock levels
V1) Expectation from advanced planning tools, giving better supply chain visibility, enabling JIT manufacturing.
C1) Ability to control, can gain further benefits with APS.
C2) Time based, needs maturity and belief in information to develop. Two tiers – 1st :direct benefit from ERP (assuming data quality), 2nd level from advanced planning tools.
C3) Puts focus on stock to enable analyses to be down, but will not have a direct impact on reducing stocks.
B1) Due mainly to correct use of advanced planning tools.
B2) Should result from APS tools (raw materials, WIP and finished goods), but can be limited by business/ supply constraints (e.g. lead times from suppliers).
B3) Level would be higher if APS applied, but reduction should be achieved if ERP philosophy is followed.
B4) Planning benefit, not ERP benefit (ERP provides basis for better data).
Summary:
General consensus is that main benefits will be experienced with APS implementation, but some benefit should result directly from ERP.

Table E2 continued...

3) Increased turnover
V1) 2005 SAP release more service focused, but need enabling tools such as CRM to get full benefits.
V2) Not directly from ERP, more from enabling tools e.g. CRM.
C1) ERP combined with APS. Through planning and scheduling, can manufacture correct stock and sell more.
C2) Over medium to long term due to increased understanding of business from the data (i.e. understand customer profitability and create focus).
C3) Depends how information is used to increase sales.
B2) Agree, but main benefits from cost reduction.
B3) Indirect benefit, due to better customer service enabled through ERP (better documentation, data, and information).
B4) Primarily from planning environment and BI tools.
B5) Depends on legacy system in place.
Summary:
Benefit mainly expected from enabling tools, but some increase could result from using ERP data, reports & information to run the business more effectively (generally considered secondary/indirect benefit).
4) Reduced IT operating costs
V1) Reduce infrastructure costs (single platform), reduce licensing costs (one vendor), reduce range of IT skills required (focused skill set).
V2) Depends on kind of company (i.e. size/industry).
C1) On one system – not maintaining multiple systems.
C2) Medium term IT costs are driven up.
C3) Investment in infrastructure and addition IT support staff will in all likelihood increase overall IT costs.
B1) Initial costs could increase. Not a major expected benefit, although depends on previous legacy systems/infrastructure in place.
B2) Initial costs of implementation as well as upgrades are high, but cost benefits at a wider company level could result over time.
B3) Depends on base, but should be expected if diverse systems to consolidate. If low level of IT systems in place, costs may increase.
B4) Ability to go to centralised service, but depends on base and alignment of IT strategy to business strategy.
B5) Due to standardization and centralization.
Summary:
Much conflict in response: Depending on current/legacy setup, if operating in a multi-system, highly supported environment IT costs should decrease due to consolidation/centralisation of systems. However, if coming from a low IT base, investment in infrastructure and additional IT support could drive costs up (especially initially).
5) Reduced quality costs
V1) ERP needs to work in conjunction with MES system to get benefit (i.e. APO linked to MES).
V2) Depends on customer objectives and governance issues around products. Also depends on mindset of implementation, i.e. if driven by production vs financial focus.
C1) Can get better data, but quality systems sit largely outside ERP.
C2) Only if specific quality focus (e.g. in pharmaceutical industries).
C3) Assists with getting information to support quality systems, but will not have a direct impact.
B1) Should not be expected initially, but should result once system is bedded down.
B2) Possible if quality module is implemented. But could also result from adopting standard operating practices.
B3) Better quality of information to execute against, but product quality determined by factory processes. (Differentiate between the two – see customer benefits).
B4) Better data and quality assurance visibility.
B5) Depends on ERP vs legacy system (many companies stay away from quality modules).
Summary:
Not the main focus of most ERP implementations, some benefit could results from focusing on better quality related data, but depends more on quality systems and procedures residing outside of ERP for costs to be reduced.

Table E2 continued...

Internal Business Benefits
1) Enhanced productivity and efficiencies
V1) Linked to plant maintenance module, providing earlier visibility and increased up time.
V2) Depends on base from which the company is coming. Ability to quantify and measure.
C1) Due to better inter-departmental communication and visibility of data.
C2) Due largely to visibility of what the business process is.
C3) Depends on setup (requires MRP/MPS etc).
B1) Due mainly to correct use of advanced planning tools.
B2) Can be enhanced through better planning (APS tools).
B3) Related to operating and admin costs – direct functions get more efficient and productive, but increased staff skills may be required.
B4) Forces discipline, but could lose flexibility. In certain situations yes, in other no.
B5) People know that the system works, reducing the need for multiple checks etc.
Summary:
Benefit is expected from increased visibility of data and processes (can take further with APS tools).
2) Improved resource utilization
V1) With regards to both from machine and human resources.
C1) Especially on machine utilization, advanced planning systems can further benefit.
C2) Direct benefit from ERP can be expected, but 2nd tier benefits from enabling software (e.g. production scheduling).
C3) Depends on having additional systems e.g. APS or BI reporting system, to provide useful information from the data.
B1) Applies to both human and machine utilization.
B2) Can be enhanced through better planning (APS tools).
B3) APS will optimise further, but following ERP philosophy should enable benefits.
B4) People – resource intensive. Machines – Advanced Planning benefit not ERP benefit.
B5) Specifically around replacing skills/experts, and managing hardware utilization.
Summary:
Expected on both people and machine side (might want to separate) in questionnaire. Can take further with enabling/APS tools.
3) Enhanced business processes
V1) Standardisation of business process, providing commonality, leading to increased efficiencies.
V2) Enhanced through leading practice (fitting the business to the system), and identifying areas where most benefit can be achieved.
C1) Base new system of best practice (refine processes through implementation).
C2) Provides opportunity to develop business processes.
C3) Direct benefit of ERP if implemented corrected.
B1) Enables companies to establish standard operation practices (SOPs).
B2) By adopting best practices associated with the ERP system.
B3) Due to best practice, more control, automation and discipline associated with ERP.
B4) By natural process of implementation, opportunity is created to enhance business processes (but depends on base and flexibility of ERP system).
B5) Due to intelligence built into ERP system, vs archaic controls within legacy systems.
Summary:
Accompanying implementation of standard/best practice operating procedures built into ERP philosophy leads to this being one of the direct benefits.

Table E2 continued...

4) Reduced manufacturing cycle times
V1) Reliant on MES solution.
V2) Depends on models implemented. There must be a manufacturing focus, e.g. focus on lean manufacturing. Additional benefits can be achieved when used in combination with enabling tools (advanced planning).
C1) Due to better access to information.
C2) Additional software (e.g. advanced planning) required to get full benefits.
C3) Depends on MPS and APS modules.
B1) Due mainly to correct use of advanced planning tools.
B2) Should improve through the use of APS tools.
B3) More APS and factory floor system related.
B4) Function of plant flexibility vs ERP.
B5) Depends on how ERP vs legacy system is utilized.
Summary:
More dependent on MES/APS systems and plant flexibility then directly from ERP.
5) Reduced data processing time
V1) Single point on entry etc.
V2) Single source of information (single point of truth).
C1) Single point of entry.
C2) Can be expected in some areas (e.g. finance), but not in others (e.g. order management).
C3) Improves reporting of financial figures, but may increase certain data capturing activities due to the amount of info to be captured (e.g. BOMs/routings etc).
B1) Depends on setup of current vs previous systems.
B2) Depends on quantity of information being captured prior to the implementation and the amount of manual documentation being used.
B3) Enter data once, but more data to enter (one offsets the other).
B4) Improved through consolidated environment, but certain process tasks (e.g. introducing a new product) can take longer.
B5)
Summary:
Single point of entry will help reduce overall data entry time, but amount of data to be entered may increase compared to legacy systems, depending on base.
6) Increased inventory turns
V1) Dependant on APO.
V2) Depends on base – if coming from low base benefit is definitely possible.
C1) Sales, manufacturing cycle etc will reduce leading to increased inventory turns.
C2) Due to increased data transparency and reporting, but requires specific focus.
C3) Depends on how information is used.
B2) Should improve with reduced stock levels.
B3) If ERP philosophy applied (e.g. target setting).
B4) Planning benefit, not ERP benefit.
B5) Depends on how efficiently system is used.
Summary:
If ERP philosophy is applied and additional reporting capabilities used correctly inventory turns should increase (does require a specific focus).

Table E2 continued...

7) Improved accuracy and timeliness of information
V1) One solution, single source of info, with enhanced reporting capabilities.
V2) Creates ability to act earlier, and make informed decisions on timely information.
C1) One of main reasons for implementing ERP (to get real time info to make decisions).
C2) Due to data quality, which is people, not system, dependent.
C3) Depends on the users input and not on the system that is used.
B1) Effort is required on the part of the business/users, and it can often be a long road to achieving this benefit..
B2) Accuracy depends on users input, but ERP system enables integrity of data to be monitored. Timeliness and availability of information enhanced through reporting (BI) tools (all required parties have access to up to date information).
B3) More focus on data and associated disciplines.
B4) One of the main benefits of going onto an ERP system.
B5) ERP systems have inherent level of accuracy that legacy systems don't have.
Summary:
One single source of information, feeding into companywide reports, places focus on accuracy, but still relies on users to input accurately. Real time information can be to be obtained from a single source of data.
8) Enhanced internal information sharing
V1) One version of the truth.
C1) Empowers people to extract info themselves (not reliant on others).
C2) The integrated nature and reporting capabilities of the solution encourages this benefit.
C3) Depends on having a BI type layer on top of the ERP system to "enforce" common information sharing (everyone looking at the same reports).
B2) Everybody has access to the same information on a daily basis.
B3) Due to integration and transparency of information.
B4) System supports information sharing (BI tools consolidate information for decision making).
B5) Access to same information at corporate level as at plant level.
Summary:
One version of the truth, info can be accessed and shared throughout the company.
9) Reduced manufacturing lead times
V1) Can do more with APO, linked to CRM.
C1) Due to better planning (APS).
C2) Possible if strong manufacturing model implemented.
C3) Depends on APS.
B1) Due mainly to correct use of advanced planning tools.
B2) Should come down with APS: improved forecasting and planning.
B4) Need agile plants, flexible suppliers, etc to reduce manufacturing lead times (ERP system has minor, if any, influence).
B5) Dependant on many external factors not necessarily driven by the system.
Summary:
Although ERP contributes to this benefit, APS and/or other enabling tools (CRM) are required for the full benefit to be achieved.

Table E2 continued...

10) Increased integration of applications
V1) Especially with new strategic direction of SAP.
V2) Single source of truth.
C1) Integral to any ERP system.
C2) Once benefit noted businesses are often motivated to strive for further integration with additional enabling systems.
C3) If managed as central system.
B1) Depends on the applications implemented and the "middleware" used.
B2) Due to using one system.
B3) Reduce auxiliary systems. Leads to other benefits (e.g. 8) (note level of benefit).
B4) Through consolidating multiple systems into one system with same look and feel.
B5) Inherent level of integrity of system integration.
Summary:
One of the primary benefits, which enables other benefits to be achieved.
11) Improved decision making
V1) ERP will give enhanced reporting leading to ability to make decisions. Need analytics associated with reporting to understand trends etc (i.e. BW would be a pre-requisite).
V2) Depends on access given to users/managers to make decisions.
C1) Access to info to do scenario planning etc.
C2) Improved info.
C3) Depends on the users and how they interpret the information. (poor decisions can still be made with improved information) Additional tools will be needed to ensure that this benefit is achieved.
B1) Depends on how the ERP reporting system is set up to report information - if setup optimally improved decision making should result.
B2) Due to greater information availability.
B3) More information to make decisions.
B4) Provides better data for decision-making, i.e. it provides the platform, but the APS tools process the data to enable better decision-making.
B5) Depends on BI systems previously bolted onto legacy system.
Summary:
Benefit due to improved reporting (information availability).
12) Improved vendor performance
V1) Need APO or SRM to get the full benefit.
V2) Enables KPIs to be set up and processes to better manage suppliers and SLAs. Again, needs to be a goal at the outset.
C1) Can manage suppliers (e.g. OTIF) better should lead to increased supplier performance.
C2) Depends on how the information is shared with the suppliers (e.g. more accurate forecasts).
C3) ERP places focus on vendor performance ensuring that the vendor complies with certain procedures.
B1) Improved information availability and sharing should enable better vendor management.
B2) By providing better information and collaborating with vendors.
B3) Depends on procurement maturity and focus (system can act as an enabler).
B4) Enables data to be fed back which can influence performance, but depends mainly on the management (often assisted by enabling tools) of the information fed back and used in the measurement process.
B5) Especially through VMI which requires standardization.
Summary:
Greater information, together with ERP procedures, enables suppliers to be managed better. However, is dependent on how info is shared.

Table E2 continued...

Customer Benefits
1) Improved customer service
V1) Can take further with CRM.
V2) Better information to understand and manage customers. ERP enables customers to be modelled better.
C1) Ability to feed back information to customers, and make accurate commitments on deliveries etc.
C2) Depends on people discipline and data accuracy.
C3) System can assist with immediate benefits as activities become procedural and formalised.
B2) Due to improved information to collaborate with customers and use of APS tools. Higher accuracy of documentation, e.g. invoicing.
B3) Due to increased information (could include admin quality)
B4) Influenced by planning more than ERP (benefit won't come just from ERP, but rather from the enabling tools as well).
B5) Depends on base
Summary:
Increased availability of information to analyse and feed back to customers leading to better customer collaboration, and therefore better customer service. Can take further with CRM.
2) Increased on time shipments
V1) ERP will improve awareness enabling bottlenecks to be identified and focus to be placed on OT shipments.
C2) ERP will help, but decision support software will make the real difference.
C3) Need BI or APS systems, as OTIF direct benefit from planning.
B2) Through APS tools (dependant on customer forecast accuracy), and improved overall business system performance.
B3) Due to increased information.
B4) Helps with accurate inventory and warehouse material handling procedures.
B5) Depends on base.
Summary:
ERP creates awareness and focus, together with higher data accuracy (e.g. stocks) should lead to improved OT shipments.
3) Improved quality
V1) QM module will help understanding of where defects may be
V2) If quality is a goal.
C1) Can manage better, but won't impact directly –down more to production line.
C3) Depends on information usage.
B1) As above, only notice improvement with time.
B2) If specific quality module installed.
B3) Affects quality of administration (information, documents etc), but not necessarily product quality.
B4) If there is a focus on quality.
B5) Depends on base.
Summary:
Can affect if specific focus is placed on quality through QA module, enabling quality defects to be measured and managed better but requires a specific focus and will not impact directly.

Table E2 continued...

4) Improved external information sharing
V1) The assimilation of information is made a lot easier.
V2) Often only comes in Phase 2/3. If focused on earlier (e.g. self service) more benefit would be achieved. (Not often seen to happen, due to fear of security etc.)
C1) Confidence in info increases willingness to collaborate with customers (collaborative planning).
C2) Same as vendor performance point, information is there, but depends on processes around sharing the data (e.g. S&OP process).
C3) Dependant on what you extract from the system (i.e. the systems linked to the ERP system to provide the necessary collaborative information).
B1) Increased availability of information should lead to multiple ways to feedback to customers and satisfy requirements.
B2) More useful information available to give to customers.
B4) More about business processes than the ERP system.
B5) Ability to interface with other (customer) systems.
Summary:
More information is available to share with customers, as well as ability to interface with customers' systems. However, the degree of benefit depends on the company's willingness to share this information.
5) Reduced service lead times
V1) Due to integration of modules etc.
V2) Due to more info being available (e.g. sales history and future demand) enables better decisions to be made going forward.
C1) Due to collaboration using ERP data.
C2) Need decision support tools to get the targeted reduction in lead times.
C3) Depends more on planning systems.
B1) Due mainly to correct use of advanced planning tools.
B2) Dependant of Forecasts etc.
B3) Should result from following ERP philosophy.
B4) No effect noted.
B5) Depends on base.
Summary:
Depends more on APS tools, but benefit could be seen from following ERP philosophy and utilising increased information. Depends on the base that the company is coming from.
Learning and Growth Benefits
1) Increased user friendliness of IS
V1) ERP system is more standard, more focused (enabling users to be up skilled in one system). New version allows users to consume SAP in a manner that is relevant to their specific roles.
V2) Users often find the system more complex, i.e. ERP may require more data to be entered, users often may not know why this extra info is required. If users have the understanding around what they are doing the system is perceived as being user friendly.
C1) Depends on complexity of ERP system chosen, users adapt over time.
C2) Generally more complicated for users initially (improves with time).
C3) Can complicate depending on base from which business is moving.
B1) Benefit exists, but takes time for users to adapt to new system.
B2) Although, most users have to go through a learning curve to adapt to the new system.
B3) More uniformity, but increased friendliness should not be expected (i.e. legacy system often simpler to use).
B4) It takes users time to get used to the new system. ERP brings discipline, but not usually user friendliness.
B5) People are specifically ERP trained vs difficulty with training of customised legacy systems.
Summary:
More standardisation, but not necessarily easier to use than legacy systems (can often be more complex and take users time to adapt).

Table E2 continued...

2) Changed work patterns
V1) Benefit due to standardisation.
V2) Determined by change management, resistance can often be expected here if not managed effectively. Needs to be managed and incentivised.
C1) ERP changes work processes, causing people to work more effectively and efficiently.
C2) ERP enforces best practice.
C3) Users are required to work in line with ERP system.
B1) ERP should allow for simplified work patterns, and standard way of working.
B2) Provides more efficient way of working.
B4) Work patterns are forced to change in line with ERP systems.
B5) Adoption of standard work patterns.
Summary:
ERP forces users to work in a standard way, following best practice methodology which is expected to result in improved work patterns.
3) Facilitates organisational learning
V1) Economies of scale in terms of one way of training users.
V2) ERP can facilitate, but it depends on organisation maturity and the guidance of a steering committee and change management to be effective.
C1) ERP creates opportunity to grow organisational knowledge (but depends on peoples' ability to change).
C2) ERP focuses on process, but not learning. If the implementation process is done correctly learning will occur, but not direct result from ERP.
C3) Through the implementation information gets shared amongst role players.
B2) Integrated system based on best practice lends itself to improved organisational learning.
B3) More formal courses etc.
B4) Because users are following standard processes, it is easy to implement standard education programmes across the company.
Summary:
Through correct implementation methodology and ability to run standard courses organisational learning should increase.
4) Empower employees to be more effective
V1) ERP provides ability to transfer process activities to people who are performing the tasks.
C1) More info and automation of data allows people to grow their roles and develop.
C2) Due to transparency of data.
C3) But depends on situation and calibre of users.
B1) Takes time to develop; should be viewed over short, medium and long term.
B2) Depends on individual and his fit within the company. More information enhances the users' abilities to do their jobs.
B3) Leads to stricter process control, which should increase effectiveness, but could also reduce employee empowerment.
B4) Forces users to follow procedures and not to be flexible. The system supports efficiencies, but not effectiveness.
B5) Should benefit, but depends on extent to which legacy system was utilized.
Summary:
Due to increased availability of information and stricter process control, users are equipped (but not necessarily empowered) to make better decisions: depends on the calibre of the users.

Table E2 continued...

5) Help build a common vision
V1) Helps roll out the vision, i.e. it is an enabler, not a driver (will not help define the strategy).
C1) ERP combined with good change management can assist build a common vision.
C2) ERP can facilitate, but it's the strategy and communication processes that build the common vision.
C3) A system can assist, but additional efforts are required from the business to create a common vision.
B1) Assists in translating vision down to business unit as well as end user level.
B2) ERP system does help, but the vision goes beyond the system.
B3) By building common philosophy into work methodology.
B4) Activities around implementation help get everyone moving in the same direction.
B5) Helps facilitate one company wide strategy.
Summary:
Will help in rolling out strategy and vision, but will not define it (enabler vs driver).

Table E3 Participant identified additional benefits

Ref	Additional Benefit	Benefits related to
C1	a) Standardisation on information. b) Better business intelligence. c) Better control of authorization (e.g. around procurement). d) History to do better forecasting.	a) Improved accuracy and timeliness of information. b) Enhanced internal information sharing. c) *Not on list.* d) Enhanced internal information sharing.
C3	Visibility of information (users have more information available to perform their jobs).	Improved accuracy and timeliness of information. Enhanced internal information sharing.
B1	Facilitates oganisational business model changes and business alignment.	Enhanced business processes. Improved decision making.
B1	Common KPIs.	*Not on list.*
B2	A standard set of KPIs linked to the system enhances performance measurement and management. (Allows for consistent measurement of individuals.)	*Not on list.*
B3	a) Flexibility – increased ability to make informed decisions to react quickly to customer demand.	Improved accuracy and timeliness of information Enhanced internal information sharing.
B3	b) Execute management philosophy – execute strategy.	Help build a common vision.
B3	c) Assists ease mergers and acquisitions – formal way of exporting way of working.	Help build a common vision.
B3	Could benefit share price – market perception if implementation successful (perceived better governance etc).	*Not on list.*
B4	Efficiencies from improved disciplines, good consolidator (platform for better data).	Enhanced productivities and efficiencies.
B5	Creating focus within the company.	Help build a common vision.

Table E4 Participant identified additional CSFs

Ref	Additional CSF
V1	Need to define solution, i.e. understand how ERP architecture fits in with IT infrastructure/strategy.
C1	Timing of project - depends on user readiness.
B2	User adherence to procedure.

Table E5 General participant comments

Ref	General Comments
V2	a) Benefits depend largely on organisational maturity and the base from which the organisation is coming.
V2	b) Advice: measure IT maturity when conducting the market research.
V2	c) CSF importance – people and processes first, technology second.
C1	a) People most important, ERP system is used as an enabler to drive the business.
C2	a) Least important CSFs are around technical points (this is largely a formality).
C3	a) The ERP system itself is not an enabler, it is the way that you set it up and the way that you use it that will determine the benefits.
C3	b) CSFs order of importance can be grouped as follows: - most important: vision, strategy and processes; - followed by: people aspects (i.e. project team and management, together with change management); and - lastly: technical aspects (i.e. if the correct strategy and people are in place this will ensure that the package selection and set-up are performed correctly).
B1	a) Many of the benefits mentioned above will only be achieved through the use of the ERP system in conjunction with advanced planning applications.
B1	b) ERP benefits should not be expected to materialise immediately, but should rather be evaluated over the short (6-9months), medium term (9-18) and long term (18months +).
B2	a) For benefits to be realised emphasis needs to be placed on the people issues that arise during an ERP implementation and its initial operation.
B3	a) Could rate CSFs as high, medium and low as many CSFs are linked (e.g. communication and training linked to change management).
B3	b) ERP success is determined more by the people aspect (how people embrace the ERP philosophy) than the technology aspect (e.g. system choice).
B4	a) Implementation should be about people first and functionality second.
B4	b) Many of the benefits listed are related more to APS or decision support tools.
B4	c) ERP supports efficiencies rather than effectiveness.

APPENDIX F: MARKET RESEARCH QUESTIONNAIRE DESIGN

Questionnaire Design Objectives

The main goals behind the design of the questionnaire were twofold:

1. Firstly, to produce a format that would enable a concise and complete set of data to be collected, that could be analysed via statistical methods (thereby avoiding miss interpretation/bias in analysing the feedback).
2. Secondly, to produce a format that would encourage a high response rate.

Design Requirements

Building on the objectives, the design requirements have been divided into two sections (data requirements and response rate):

Data requirements

To ensure that sufficient data is collected, for a complete and thorough analysis to take place, the following information is required:

1. Participant information, regarding the nature of business, organisational size and industry must be collected to enable a breakdown of the sample set to be provided. This will assist the researcher in determining the applicability of each response to the results as well as address external factors that may contribute to the level of benefits achieved.
2. Information surrounding possible influencing factors on ERP benefits, as identified via the literature review and market interviews.
3. Feedback regarding the level to which each CSF was in place during the implementation cycle.
4. Feedback regarding the level to which ERP benefits have been achieved in the three defined post “go-live” periods.

Response rate

The following design factors have been found to increase the response rates of questionnaires and have been incorporated into the design:

1. Length of questionnaire: multiple studies and authors (e.g. Sheehan, 2001; Leedy and Ormrod, 2005) have found and recommend that the response rate is inversely proportional to the length of the questionnaire, i.e. the shorter the questionnaire the higher the response rate.
2. Inclusion of a covering letter (Leedy and Ormrod, 2005, pp193-196): the wording of the covering letter is essential for this study as it is used to:
    a. Confirm a personal contact (established through the initial telephone call).
    b. Obtain the readers interest in the study (a factor that has been found to influence response rate (Sheehan & McMillan, 1999)).
    c. Motivate the reader to respond (Leedy & Ormrod, 2005, p193).
    d. Provide the reader with instructions on how to complete and return the questionnaire.
    e. Assure the reader of anonymity (shown by Faria & Dickson, (1996) to increase response rate).
    f. Incentivise the reader to participate in the study through offering the results of the study (Leedy & Ormrod, 2005, p194).
3. The design layout: by adopting a uniform layout throughout, the participant should gain familiarity with the questionnaire style, decreasing time to complete the questionnaire (Borgatti, 1996).
4. Question placement: by placing easier questions at the beginning of the survey the participant becomes comfortable with the questionnaire before moving on to more challenging questions (Borgatti, 1996).

Design Methodology

The following design methodology was followed to ensure that the design objectives were met:

1. Design requirements were taken into account.
2. A draft questionnaire was compiled based on the design requirements.
3. A pilot study was conducted to test the questionnaire and remedy any weaknesses.
4. A final design was produced, for use in the market research.

Questionnaire Design

Draft design

Taking the above design requirements into consideration, the following questionnaire, consisting of three MS Excel worksheets, was designed:

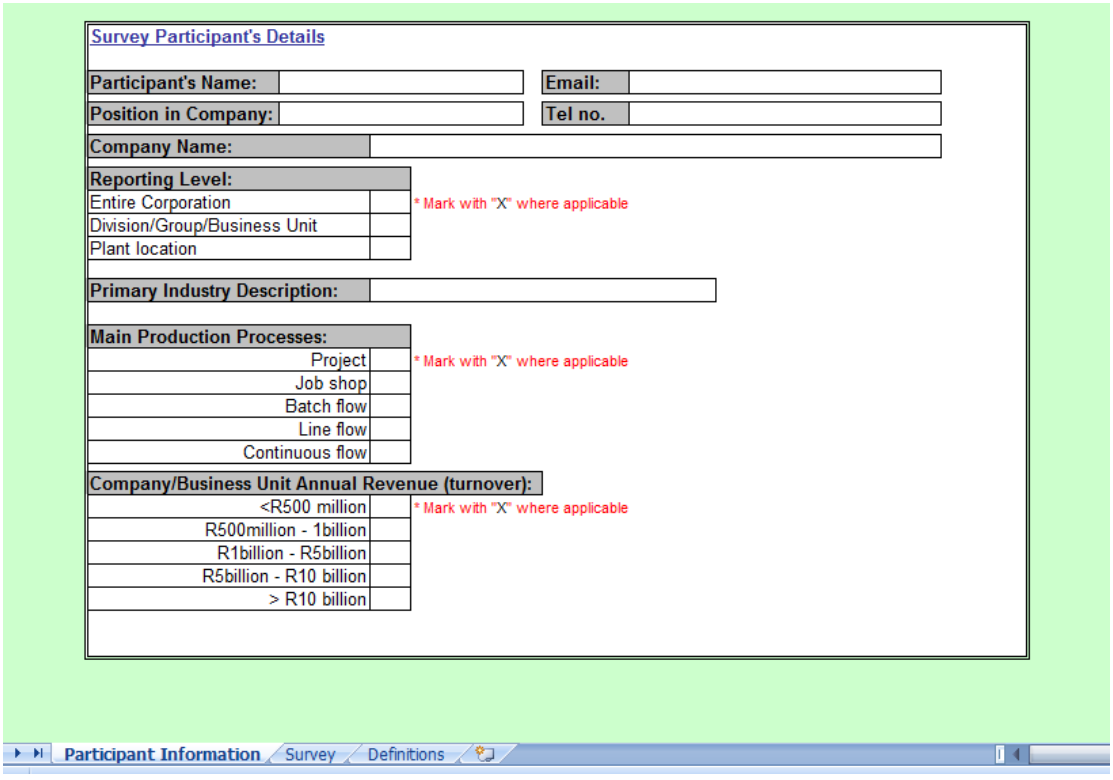


Figure F1 Survey participant information

ERP Benefits and CSF Survey

Survey Objectives:

The purpose of this questionnaire is to draw on the respondent's knowledge of his/her company's ERP system to determine:

1. The level of benefits that have been achieved through the implementation.
2. The factors that were in place during the implementation lifecycle that may have contributed to the impact of the system on business performance.

Survey Questions:

Note: select answers from dropdown lists in Blue cells

1) Indicate the extent to which the following systems have been implemented at your company:

Degree of Implementation

SCALE	
	1 = no implementation
	2 = some implementation
	3 = extensive implementation

* Select from dropdown list. Populate all coloured cells

System	Degree of Implementation
Enterprise resource planning system (ERP)	1
Forecasting/demand planning software	
Advanced planning & scheduling (APS)	
Quality management system (QMS)	
Customer relationship management (CRM)	
Supplier relationship management (SRM)	

1
2
3

2) ERP system implemented:
Specify if other:

3) Year that your company went live with ERP:

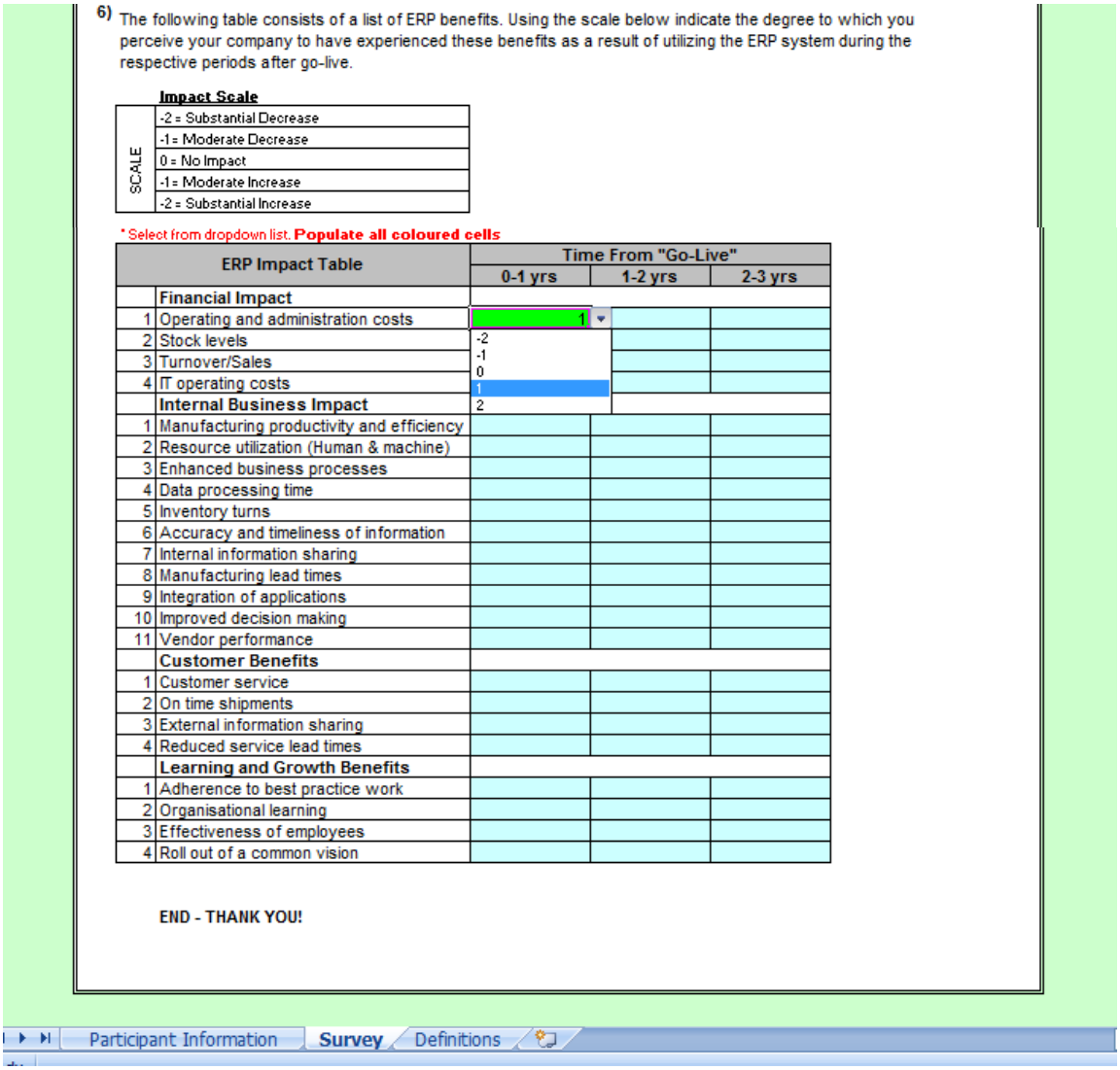
4) Legacy systems in place prior to ERP:

Critical Success Factors

5) By placing an "X" from the dropdown list, indicate the extent to which the factors listed below took place during your ERP implementation cycle:

* Mark with "X" where applicable (mark 1 cell per row)

	Factor	To a great extent	Somewhat	Very little	Not at all
1	Business plan, vision & strategy	X			
2	Business process re-engineering				
3	Change management				
4	Education and training				
5	Effective communication				
6	Effective ERP team composition				
7	Minimum customisation				
8	Project management				
9	Software development, testing &				
10	Top management commitment				



6) The following table consists of a list of ERP benefits. Using the scale below indicate the degree to which you perceive your company to have experienced these benefits as a result of utilizing the ERP system during the respective periods after go-live.

SCALE	Impact Scale
	-2 = Substantial Decrease
	-1 = Moderate Decrease
	0 = No Impact
	-1 = Moderate Increase
	-2 = Substantial Increase

* Select from dropdown list. **Populate all coloured cells**

	ERP Impact Table	Time From "Go-Live" 0-1 yrs	1-2 yrs	2-3 yrs
	Financial Impact			
1	Operating and administration costs	1		
2	Stock levels			
3	Turnover/Sales			
4	IT operating costs			
	Internal Business Impact			
1	Manufacturing productivity and efficiency			
2	Resource utilization (Human & machine)			
3	Enhanced business processes			
4	Data processing time			
5	Inventory turns			
6	Accuracy and timeliness of information			
7	Internal information sharing			
8	Manufacturing lead times			
9	Integration of applications			
10	Improved decision making			
11	Vendor performance			
	Customer Benefits			
1	Customer service			
2	On time shipments			
3	External information sharing			
4	Reduced service lead times			
	Learning and Growth Benefits			
1	Adherence to best practice work			
2	Organisational learning			
3	Effectiveness of employees			
4	Roll out of a common vision			

-2
-1
0
1
2

END - THANK YOU!

Participant Information | Survey | Definitions

Figure F2 ERP survey questions

ERP Benefit	Description
Financial Impact	
Operating and administration costs	*Operating costs* are the recurring expenses which are related to the operation of a business (comprising of fixed and variable costs).
	Administration costs are all expenses related to performing business administration tasks, including cost of administration personnel, stationary, related equipment and office space.
Stock levels	Raw material, work in progress and finished goods stock levels.
Sales	Yearly Revenue generated by product sales.
IT operating costs	Includes hardware infrastructure costs, software licence costs, and IT support costs.
Internal Business Impact	
Manufacturing productivity and efficiency	Manufacturing productivity is the ratio of what is produced to what is required to be produced. Efficiency is the rate at which this production is achieved.
Resource utilization (Human & machine)	Resources include assets and personnel across the organisation: manufacturing resources (e.g. machines, material handlers, etc.); storage resources (e.g. warehouses); logistics resources (e.g. trucks, cargo carriers); human resources (e.g. labour, admin and management personnel); and financial (working capital, stocks, etc.). Utilization refers to the optimised use of these resources.
Enhanced business processes	A business process is any set of activities performed by a business that is initiated by an event, transforms information, materials or business commitments, and produces an output.
Data processing time	Overall time taken to process data on ERP system versus legacy system (I.e. data may need to be captured only once on an ERP system, but there is more of it to capture).
Inventory turns	The number of times that a company's inventory cycles or turns over per year (Inventory Turns = Annual Cost of Sales/Average Inventory Level).
Accuracy and timeliness of information	Accuracy refers to minimal capture and calculation errors. Timeliness refers to the lapse of time between an event occurring and the information surrounding that event being available.
Internal information sharing	The degree to which information is available/shared within the user community within a business (e.g. through reporting, live data on system etc).
Manufacturing lead times	The manufacturing lead time is the period of time between the start of production on a specific job and the completion of the manufacturing process on that job.
Integration of applications	The linking of IT systems to enable the electronic sharing of data/information between the different systems.
Improved decision making	The degree to which the ERP system has assisted in providing the business managers and system users with improved information to enable more effective/profitable decisions to be made.
Vendor performance	Supplier performance in terms of on time deliveries (reliability), quality of information sharing and quality of product received.
Customer Benefits	
Customer service	The ability to fulfil the customers' needs and requirements of a supplier, for example: OTIF (On time in full delivery), information sharing and customer relations.
On time shipments	On time shipment of goods refers to orders being shipped/dispatched on or before the customer requested shipping date.
External information sharing	The sharing of relevant information and reports with customers.
Reduced service lead times	The service lead time references to the time between a customer placing an order and the order being fulfilled/delivered to the customer.
Learning and Growth Benefits	
Adherence to best practice work patterns	Best practice work patterns refer to the optimal workflows for completing a given task or process (as defined by the business or industry).
Organisational learning	The degree to which education and training are facilitated within the business (e.g. through standardised courses and teaching common processes).
Effectiveness of employees	The degree to which the employees effect a positive operational/financial improvement within the business.
Roll out of a common vision	The extent to which the company's vision is adopted/embraced by the employees.

Figure F3 Survey definitions

Design description

The questionnaire was designed in Microsoft Office Excel 97-2003. This application was chosen as it is widely used in business and it is expected that all participants targeted for this survey would be familiar with the package and would therefore feel comfortable with this format. The design makes use of a spreadsheet consisting of three worksheets to gather the required information:

1. "Participant information" – asks for general participant information and descriptions of company operations and size. This data is used to ensure that the questionnaire has been completed by an appropriate person. It also allows for further analyses to be performed on company size and process type.
2. "Survey" – this worksheet forms the body of the survey and asks for the relevant background information and influencing factors before moving on to the detailed CSF and benefits questions which form the core of this research.
3. "Definitions" – the definitions worksheet contains definitions of the individual benefits found on the "Survey" worksheet. These definitions were included to provide the participant with clarity on how each benefit should be understood. Definitions were not provided for the CSFs as these are terms that are common place in business.

The questionnaire makes use of drop down lists and tables wherever possible, to facilitate the efficient completion of the questionnaire (initially estimated to take approximately 15 minutes, but tested in the pilot interviews). The use of Likert scales on the tables allows for descriptive statistics to be effectively applied in analysing the data.

"Participant Information" worksheet. Overview and company background information are asked for on this worksheet. This information should be straight forward for the participant to answer. By placing this part first it allows the user to gain familiarity and comfort with the questionnaire and its format, while not being

challenged on content information. The worksheet asks for the following information:

1. The participant's name and contact details: are requested to clarify who is completing the survey, and provide a means to contact them in future should further information be required.
2. Position in company: is used to gauge whether or not the participant is in a suitable position to complete the survey on behalf of the organisation.
3. Company name: is used to confirm the organisation on behalf of which the participant is replying.
4. Reporting level: is used to determine for what level of the business the participant is answering the questionnaire.
5. Primary industry description: is used to analyse the responses to ensure that a sufficient spread of industries is represented, so as not to bias the analysis in favour of a particular industry.
6. Main production processes: is used to determine if a satisfactory spread regarding the type of manufacturing process is represented in the results, or if there is potential for bias towards certain process industries.
7. Company/business unit annual revenue: is used to analyse results by company size to determine if results could be biased by the size of the organisations represented.

"Survey" worksheet. As described in the overview section above, this worksheet forms the body of the questionnaire and is used to gather all the necessary benefits and CSF data as well as information that could influence performance. The worksheet makes use of tables and dropdown lists wherever possible, creating a uniform format, to enable the user to gain familiarity with the format as specified by the design requirements. The influencing factors are addressed first as these questions are fairly quick to answer, followed by the CSF table which is expected to take more time, and finally by the ERP benefits table which is expected to take the bulk of the time to complete. By structuring the questionnaire in this manner (i.e. shorter questions first) it is hoped that the participant will not be discouraged early on by a high expected completion time and will complete the questionnaire

through to the end. Before proceeding with the questions, a "survey objectives" overview is provided to remind the participants of the purpose and objectives of the survey to enable them to get their thoughts aligned before they start to answer the questions (a more detailed description is provided in the covering letter). This section contains the following questions:

1. Question 1 asks for the extent to which certain enabling systems are in place. This selection has been included as the interview findings indicate that it is the addition of these enabling systems that might have a greater impact on organisational performance than operating on a standalone ERP setup. The extent to which ERP itself has been implemented has also been included as some companies may have only done a partial implementation (i.e. implemented certain modules, or still be in the implementation cycle) – a factor which could lead to bias in the results.
2. Question 2 asks for the brand of ERP system implemented (e.g. SAP, JDE, etc). Although this study is not investigating the performance benefits between different ERP systems, it is important that this information is included so as not to bias the results in favour of a particular make of ERP system.
3. Question 3 asks for the year that the ERP system went live. Since ERP systems and implementation methodologies have evolved over time, this could be a significant influencing factor on performance results, and therefore needs to be taken into account when analysing the results.
4. Question 4 asks for the list of legacy systems in place prior to "go-live". This is deemed to be a significant influencing factor as the comments from the structured interviews indicate that those companies moving onto ERP systems from a more established IT base could expect greater benefits (specifically in the case of IT operating costs).
5. Question 5 asks for details regarding the extent to which the indentified CSFs were in place during the implementation cycle. A four point Likert scale is used to compile the question into tabular form. The Likert scale has been limited to four categories as it was felt that further granularity would not yield more accurate responses and may confuse the participants,

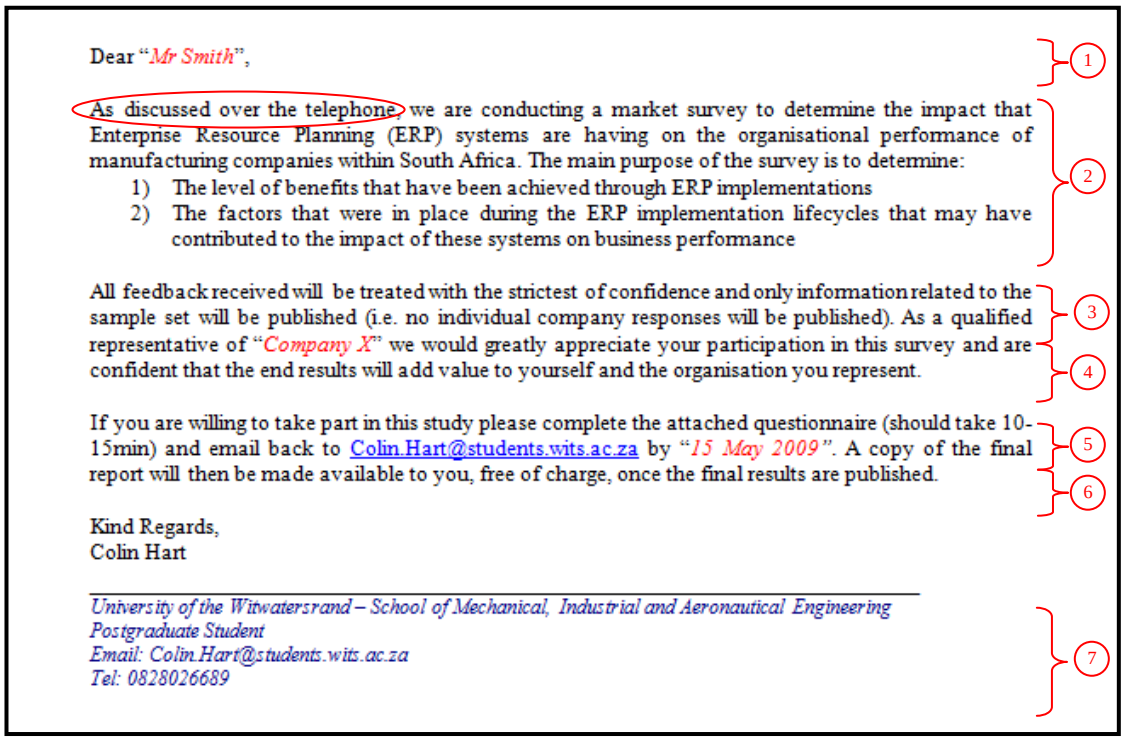
increasing the completion time of the questionnaire. (This is tested in the pilot study to see if these assumptions are valid.)

6. Question 6 makes use of a five point rating scale to complete a time phased table describing the degree to which benefits have been achieved post "go-live". As a negative impact on performance may have been noticed in certain areas, the rating scale has been designed to include indications of a decrease as well as an increase in performance. As this question not only contains the most critical area of feedback, but is also the most complex question to complete, it is vital that the users' understanding of completing this question is thoroughly tested through the pilot study.

"Definitions" worksheet. The final worksheet contains definitions of the benefits being investigated. This is done to avoid misinterpretation. These definitions were composed out of the literature review section of the research.

Covering letter

Taking the design requirements into account, the following covering letter (sent as the body of the email to the participant) was composed:



Dear "*Mr Smith*",

As discussed over the telephone, we are conducting a market survey to determine the impact that Enterprise Resource Planning (ERP) systems are having on the organisational performance of manufacturing companies within South Africa. The main purpose of the survey is to determine:

1) The level of benefits that have been achieved through ERP implementations
2) The factors that were in place during the ERP implementation lifecycles that may have contributed to the impact of these systems on business performance

All feedback received will be treated with the strictest of confidence and only information related to the sample set will be published (i.e. no individual company responses will be published). As a qualified representative of "*Company X*" we would greatly appreciate your participation in this survey and are confident that the end results will add value to yourself and the organisation you represent.

If you are willing to take part in this study please complete the attached questionnaire (should take 10-15min) and email back to Colin.Hart@students.wits.ac.za by "*15 May 2009*". A copy of the final report will then be made available to you, free of charge, once the final results are published.

Kind Regards,
Colin Hart

University of the Witwatersrand – School of Mechanical, Industrial and Aeronautical Engineering
Postgraduate Student
Email: Colin.Hart@students.wits.ac.za
Tel: 0828026689

Figure F4: Survey covering letter

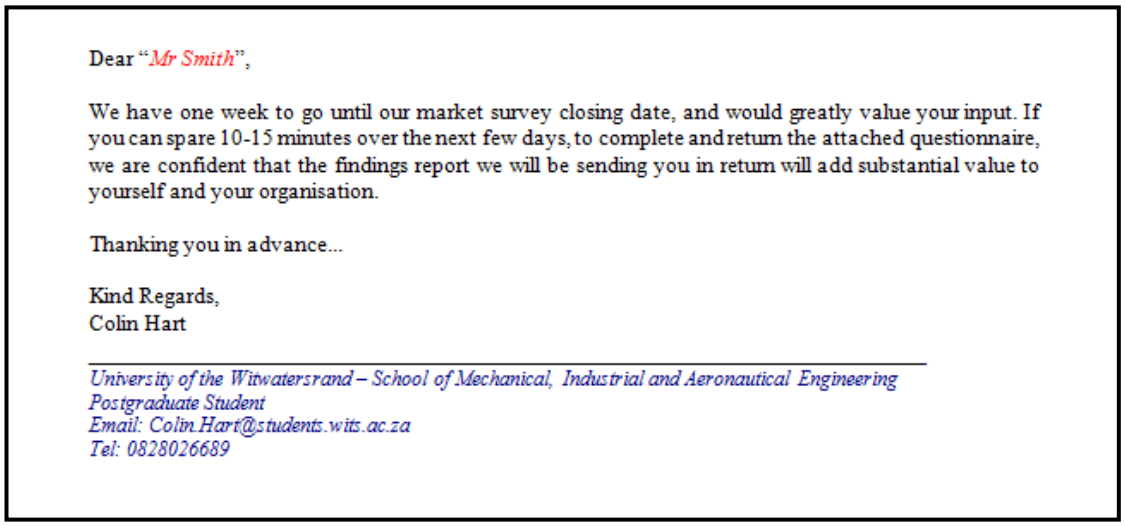
The covering letter has been kept as concise as possible so as not to deter the participant by its length, while still incorporating the key design requirements. The researcher has aimed to keep the tone courteous and professional throughout. The design requirements of the covering letter are highlighted via the numbers on the figure above and described below:

1. The letter is personally addressed to the participant, to encourage interest and build on the relationship established through the initial telephone call.
2. The text, "As discussed over the telephone" is included if personal contact was made. This is used to reinforce the telephone discussion. If the researcher is unable to get through to the participant directly by telephone (e.g. may have spoken to secretary) and this is the first form of direct contact, then this phrase is left out. The rest of this paragraph is used to inform the participant of the study and to gain his/her interest.

3. This sentence assures the participant of anonymity.
4. This sentence is used to motivate the reader to participate by appealing to him/her by stressing the researcher's need for information, as well as the value that the research could add to their organisation.
5. This section provides the instructions of what is required of the participant (i.e. complete the questionnaire) and to whom and by when the questionnaire needs to be returned. (The date is highlighted above as not all questionnaires were sent on the same day, but the lead time to return the questionnaire remains fixed at two weeks.) The time to complete the question is also provided to indicate to the reader that completing the questionnaire should not consume much time.
6. Here the results of the report are offered to incentivise the reader to participate.
7. The researcher's contact details are included should the participant need clarity on any aspect of the survey.

Reminder letter

As the completion date has not been exceeded at this point, the purpose of this email is simply to remind the participant of the survey and emphasize that their input is still valued. The points of "time to complete", as well as "value to the participant", are re-iterated in this letter to encourage a response. (The Excel questionnaire is sent again with this email.)



Dear "*Mr Smith*",

We have one week to go until our market survey closing date, and would greatly value your input. If you can spare 10-15 minutes over the next few days, to complete and return the attached questionnaire, we are confident that the findings report we will be sending you in return will add substantial value to yourself and your organisation.

Thanking you in advance...

Kind Regards,
Colin Hart

University of the Witwatersrand – School of Mechanical, Industrial and Aeronautical Engineering
Postgraduate Student
Email: Colin.Hart@students.wits.ac.za
Tel: 0828026689

Figure F5: Reminder letter

Final reminder letter

This letter is sent to the participant if no response is received by the requested deadline date. The tone of this letter is one of appealing for assistance. Once again emphasis is placed on the value of the study and the minimal time required to complete the questionnaire. Again the Excel questionnaire is attached to the email.

Dear "*Mr Smith*",

We appreciate that your time is limited, and that a person in your position must be constantly inundated with questionnaires of this nature. However, the responses that have been received to date have been very encouraging and promise to lead to some interesting and valuable findings within the Enterprise Resource Planning field.

We do however feel that the study would be incomplete without the input from a major player such as yourselves, and therefore kindly ask if you could spare 10-15 minutes within the next few days to complete and return the questionnaire (attached again in case previous email was not received).

Once the results are compiled a final report will be sent to you, free of charge, which will enable you to benchmark your ERP implementation and optimise your future business strategies.

We shall appreciate your kindness.

Kind Regards,
Colin Hart

University of the Witwatersrand – School of Mechanical, Industrial and Aeronautical Engineering
Postgraduate Student
Email: Colin.Hart@students.wits.ac.za
Tel: 0828026689

Figure F6 Final reminder letter

Pilot Study

Objectives

The main aim of the pilot study was to test the questionnaire with a sample of users to determine if:

1. The users would feel comfortable with receiving the covering letter and follow up letters, and whether they concur with the format, length and tone of the letters.
2. The worksheets and question format on the questionnaire spreadsheet were clear and easy for the participants to understand and follow.
3. The content being requested could be clearly understood for each question (with details and recommendations to be provided where questions are not clear).
4. The participant was able to accurately supply the requested data.
5. The questionnaire could be satisfactorily completed within the anticipated time.

Methodology

As the survey targets senior executives/managers at a group, division and plant level, the questionnaire was tested at each of these levels. To sufficiently test the questionnaire it was decided that one participant operating at each of these levels (group, division and plant) would be required (i.e. 3 participants in total). The questionnaire was tested as follows:

1. Three participants (one at a group level, one at a divisional level and one at a plant) were identified.
2. The identified individuals were contacted via telephone to obtain their commitment to the process.
3. The participant was emailed a copy of the questionnaire with the covering letter forming the body of the email. The participant was requested to complete the questionnaire taking note of any areas that were unclear as well as any recommendations that they had. They were asked to keep note of the time that it took to complete the questionnaire.

4. Once the participant had been given sufficient time to complete the questionnaire, a meeting was set up between the researcher and participant to discuss feedback and recommendations. The meetings used the format of the questionnaire to form the agenda for discussion (i.e. the questionnaire was discussed one question at a time).
5. Once all three questionnaires and follow up meetings had been completed, the findings and recommendations were compiled and built into the questionnaire design where applicable.

Findings

Three individuals were identified who willingly agreed to take part in the pilot survey: a CIO (group level), a Supply Chain Director (divisional level), and a General Manger (plant level). The findings, aligned with the objectives above, were as follows:

1. All users felt comfortable with receiving the covering letter and agreed that the tone was acceptable and the content clear and concise.
2. Although all users were able to navigate the three worksheets on the questionnaire, the comment was made by two of the participants that there is a risk that the users may only complete the participant information and not notice the other worksheets. They also pointed out that as they were not directed to the definitions worksheet next to the appropriate question, they only referred to the definitions after completing the questions.
3. In terms of content the following comments were made for each section:

   Participant information:

   a) It was not clear that by indicating the "reporting level" that this would be the level at which the questionnaire would be answered.
   b) Further clarity was required on the description of the "production processes" to be selected. It was recommended that definitions be included for these terms.

Survey questions:

a) In all three cases the users commented that restating the survey objectives at the top of the sheet was unnecessary as they had the covering letter to refer to.
b) It was commented by two participants that the rating scale in "question 1" indicating the "degree of implementation" did not include sufficient options to differentiate the varying degrees of implementation for the applications in their company.
c) "Question 4" regarding the legacy systems in place prior to the ERP system, caused confusion amongst all three users as they all had more than three legacy systems in place (in one case there was an ERP system in place prior to the current ERP system).
d) The impact scale in "question 6" was found to be slightly limiting and initially unclear. The rewording and redefining of the rating scale was agreed with all three participants.
e) In one case the user was not clear that an answer had to be provided for all three time periods in "question 6".

Definitions:

All definitions were clearly understood by the participants.

4. In all three cases the participants commented that they had sufficient knowledge to supply answers for all of the questions that were asked in the questionnaire.
5. All users stated that they completed the questionnaire within 15 minutes.

Design changes

Taking the findings of the pilot survey into consideration, a number of adjustments were made to the questionnaire design. The major changes were:

General layout:

1. The participant worksheet was combined with the survey worksheet. This is to ensure that the participant does not miss the survey worksheet when completing the questionnaire.

Participant information:

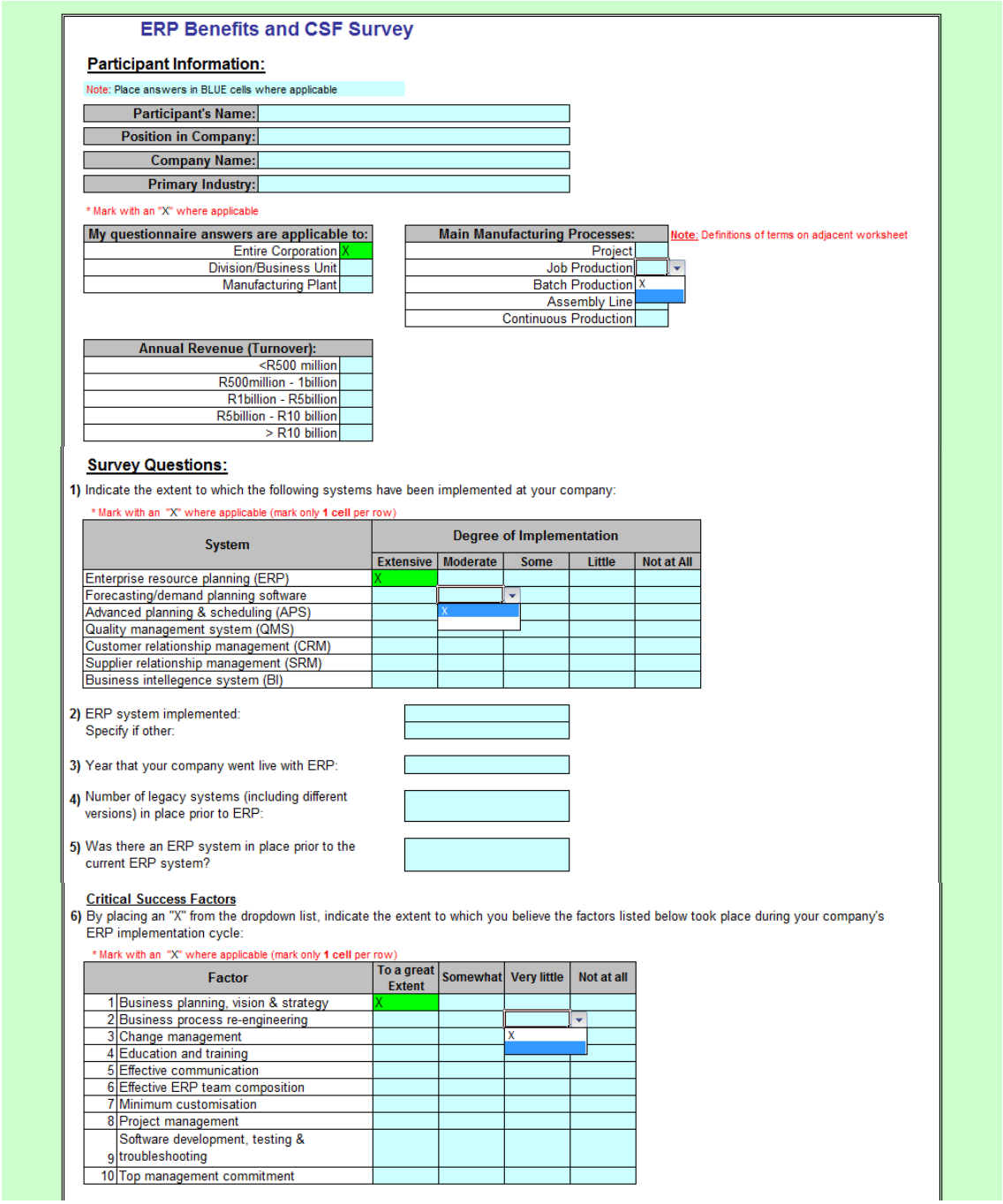
1. The "email" and "telephone" requests were removed, as this data was obtained through compiling the sample set.
2. A clearer description on what level the participant would answer the questionnaire (i.e. entire corporation, division/business unit or manufacturing plant) was provided.
3. Definitions for the manufacturing processes were provided on the "definitions" worksheet and referred to next to the appropriate table.

Survey questions:

1. The survey objectives were removed as per the recommendations.
2. The rating scale for "question 1" was expanded and the question was displayed in tabular form to facilitate completion and allow the participant to view their answers in relation to each other. This change also provided the questionnaire with a more uniform appearance.
3. "Question 4" (regarding the legacy system data) was split into two questions. The first question asks for the number of legacy systems in place prior to ERP implementation, and the second question determines if an ERP system was in place prior to the current implementation.
4. The rating scale in "question 6" was adjusted as per the descriptions agreed with the participants.
5. A warning message was added to indicate to users that the cells need to be populated for all three time periods (the message disappears once all three cells per row are populated).
6. A note was added above the ERP benefits table to point users to the "definitions" worksheet should they require clarification.

Final Design

A copy of the final questionnaire design is shown below and a version of the Excel file has been submitted with the report. By viewing the Excel file the reader is able to view the full range of dropdown lists and warning messages that have been included in the design.



ERP Benefits and CSF Survey

Participant Information:

Note: Place answers in BLUE cells where applicable

Participant's Name:	
Position in Company:	
Company Name:	
Primary Industry:	

* Mark with an "X" where applicable

My questionnaire answers are applicable to:	
Entire Corporation	X
Division/Business Unit	
Manufacturing Plant	

Main Manufacturing Processes:	
Project	
Job Production	
Batch Production	X
Assembly Line	
Continuous Production	

Note: Definitions of terms on adjacent worksheet

Annual Revenue (Turnover):	
<R500 million	
R500million - 1billion	
R1billion - R5billion	
R5billion - R10 billion	
> R10 billion	

Survey Questions:

1) Indicate the extent to which the following systems have been implemented at your company:

* Mark with an "X" where applicable (mark only **1 cell** per row)

System	Degree of Implementation				
	Extensive	Moderate	Some	Little	Not at All
Enterprise resource planning (ERP)	X				
Forecasting/demand planning software					
Advanced planning & scheduling (APS)		X			
Quality management system (QMS)					
Customer relationship management (CRM)					
Supplier relationship management (SRM)					
Business intellegence system (BI)					

2) ERP system implemented:
Specify if other:

3) Year that your company went live with ERP:

4) Number of legacy systems (including different versions) in place prior to ERP:

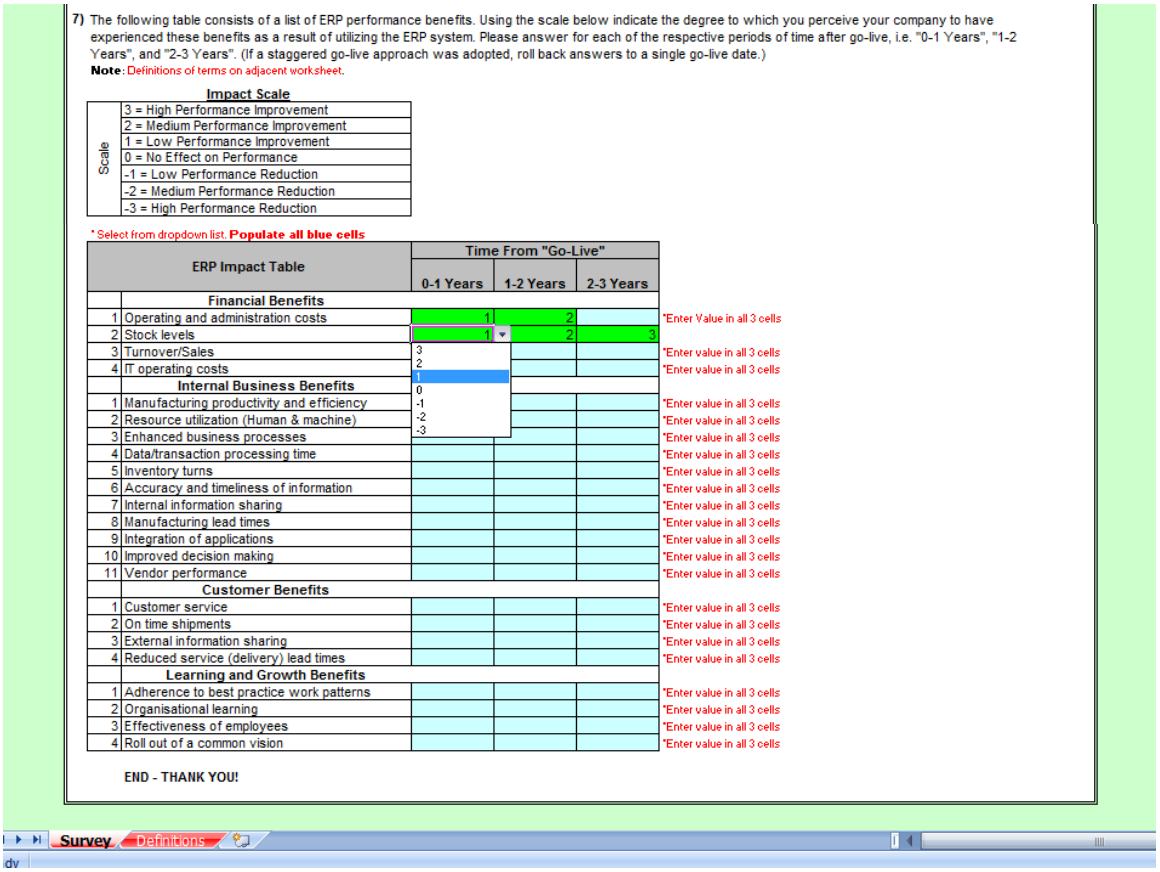
5) Was there an ERP system in place prior to the current ERP system?

Critical Success Factors

6) By placing an "X" from the dropdown list, indicate the extent to which you believe the factors listed below took place during your company's ERP implementation cycle:

* Mark with an "X" where applicable (mark only **1 cell** per row)

	Factor	To a great Extent	Somewhat	Very little	Not at all
1	Business planning, vision & strategy	X			
2	Business process re-engineering				
3	Change management			X	
4	Education and training				
5	Effective communication				
6	Effective ERP team composition				
7	Minimum customisation				
8	Project management				
9	Software development, testing & troubleshooting				
10	Top management commitment				



7) The following table consists of a list of ERP performance benefits. Using the scale below indicate the degree to which you perceive your company to have experienced these benefits as a result of utilizing the ERP system. Please answer for each of the respective periods of time after go-live, i.e. "0-1 Years", "1-2 Years", and "2-3 Years". (If a staggered go-live approach was adopted, roll back answers to a single go-live date.)

Note: Definitions of terms on adjacent worksheet.

Impact Scale

Scale	
	3 = High Performance Improvement
	2 = Medium Performance Improvement
	1 = Low Performance Improvement
	0 = No Effect on Performance
	-1 = Low Performance Reduction
	-2 = Medium Performance Reduction
	-3 = High Performance Reduction

*Select from dropdown list. **Populate all blue cells**

	ERP Impact Table	Time From "Go-Live" 0-1 Years	1-2 Years	2-3 Years	
	Financial Benefits				
1	Operating and administration costs	1	2		*Enter Value in all 3 cells
2	Stock levels	1	2	3	
3	Turnover/Sales				*Enter value in all 3 cells
4	IT operating costs				*Enter value in all 3 cells
	Internal Business Benefits				
1	Manufacturing productivity and efficiency				*Enter value in all 3 cells
2	Resource utilization (Human & machine)				*Enter value in all 3 cells
3	Enhanced business processes				*Enter value in all 3 cells
4	Data/transaction processing time				*Enter value in all 3 cells
5	Inventory turns				*Enter value in all 3 cells
6	Accuracy and timeliness of information				*Enter value in all 3 cells
7	Internal information sharing				*Enter value in all 3 cells
8	Manufacturing lead times				*Enter value in all 3 cells
9	Integration of applications				*Enter value in all 3 cells
10	Improved decision making				*Enter value in all 3 cells
11	Vendor performance				*Enter value in all 3 cells
	Customer Benefits				
1	Customer service				*Enter value in all 3 cells
2	On time shipments				*Enter value in all 3 cells
3	External information sharing				*Enter value in all 3 cells
4	Reduced service (delivery) lead times				*Enter value in all 3 cells
	Learning and Growth Benefits				
1	Adherence to best practice work patterns				*Enter value in all 3 cells
2	Organisational learning				*Enter value in all 3 cells
3	Effectiveness of employees				*Enter value in all 3 cells
4	Roll out of a common vision				*Enter value in all 3 cells

3
2
1
0
-1
-2
-3

END - THANK YOU!

Survey Definitions

Figure F7 Final ERP survey questions worksheet

Definitions

Term	Description
Manufacturing Processes	
Project	A project consists of a temporary endeavour undertaken to create a product or service (often unique in nature). "Temporary" meaning that the project will have a specific start-date and end-date. Projects are usually constrained by time, costs and resources, and are performed by a project team who broadly follow a detailed project plan.
Job Production	Job production involves producing a one-off product for a specific customer. Job production is most often associated with small firms (e.g. railings for a specific house, building/repairing a computer for a specific customer) but can also be performed by large firms (e.g. installing machinery in a factory).
Batch Production	Batch production is used to produce or process any product in discrete batches. The primary characteristic of batch production is that all components are completed at a workstation before they move to the next one.
Assembly Line	An assembly line is a manufacturing process in which interchangeable parts are added to a product in a sequential manner using optimally planned logistics to create a finished product much faster than with handcrafting-type methods (e.g. motor industry).
Continuous Production	Continuous production is a method used to manufacture, produce, or process any product without interruption. There is no discrete rate at which goods are produced, as opposed to a batch production process, or job production.
Financial Benefits	
Operating and administration costs	*Operating costs* are the recurring expenses which are related to the operation of a business (comprising of fixed and variable costs) *Administration costs* are all expenses related to performing business administration tasks, including cost of administration personnel, stationary, related equipment and office space.
Stock levels	Raw material, work in progress and finished goods stock levels
Sales	Yearly Revenue generated by product sales
IT operating costs	Includes hardware infrastructure costs, software licence costs, and IT support costs
Internal Business Benefits	
Manufacturing productivity and efficiency	Manufacturing productivity is the ratio of what is produced to what is required to be produced. Efficiency is the rate at which this production is achieved.
Resource utilization (Human & machine)	Resources include assets and personnel across the organisation: manufacturing resources (e.g. machines, material handlers, etc.); storage resources (e.g. warehouses); logistics resources (e.g. trucks, cargo carriers); human resources (e.g. labour, admin and management personnel); and financial (working capital, stocks, etc.). Utilization refers to the optimised use of these resources.
Enhanced business processes	A business process is any set of activities performed by a business that is initiated by an event, transforms information, materials or business commitments, and produces an output
Data/transaction processing time	Overall time taken to process data on ERP system versus legacy system (i.e. data may need to be captured only once on an ERP system, but there is more of it to capture).
Inventory turns	The number of times that a company's inventory cycles or turns over per year (Inventory Turns = Annual Cost of Sales/Average Inventory Level).
Accuracy and timeliness of information	Accuracy refers to minimal capture and calculation errors. Timeliness refers to the lapse of time between an event occurring and the information surrounding that event being available.
Internal information sharing	The degree to which information is available/shared within the user community within a business (e.g. through reporting, live data on system, etc).
Manufacturing lead times	The manufacturing lead time is the period of time between the start of production on a specific job and the completion of the manufacturing process on that job.
Integration of applications	The linking of IT systems to enable the electronic sharing of data/information between the different systems.
Improved decision making	The degree to which the ERP system has assisted in providing the business managers and system users with improved information to enable more effective/profitable decisions to be made.
Vendor performance	Supplier performance in terms of on time deliveries (reliability), quality of information sharing and quality of product received.
Customer Benefits	
Customer service	The ability to fulfil the customers' needs and requirements of a supplier, for example: OTIF (On time in full delivery), information sharing and customer relations.
On time shipments	On time shipment of goods refers to orders being shipped/dispatched on or before the customer requested shipping date.
External information sharing	The sharing of relevant information and reports with customers.
Reduced service lead times	The service lead time references to the time between a customer placing an order and the order being fulfilled/delivered to the customer.
Learning and Growth Benefits	
Adherence to best practice work patterns	Best practice work patterns refer to the optimal workflows for completing a given task or process (as defined by the business or industry).
Organisational learning	The degree to which education and training are facilitated within the business (e.g. through standardised courses and teaching common processes).
Effectiveness of employees	The degree to which the employees effect a positive operational/financial improvement within the business.
Roll out of a common vision	The extent to which the company's vision is adopted/embraced by its employees.

Figure F8 Final ERP survey definitions worksheet

APPENDIX G: SAMPLE CALCULATIONS

Significance Levels - p131

The significance levels in Table 5.2 are calculated using the method described by Johnson (2000, p373) on the basis of the Fisher Ƶ transformation. Taking r = 0.3:

$$Ƶ = \frac{1}{2} ln \frac{1+r}{1-r} \quad \text{(G1)}$$

$$Ƶ = \frac{1}{2} ln \frac{1.3}{0.7}$$

$$Ƶ = 0.310$$

and

$$Z = \sqrt{n-3} \times Ƶ \quad \text{(G2)}$$

$$Z = \sqrt{14} \times 0.310$$

$$Z = 1.16$$

Assuming a normal distribution, Table G1 is used to determine the significance level.

For Z = 1.16, the significance level is 87.7%.

Table G1 Standard normal distribution function

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998
3.5	0.9998									
4.0	0.99997									
5.0	0.9999997									

Johnson (2000, p575)

Confidence Intervals (ERP Benefits) – p150

The confidence intervals in Table 5.4 are calculated using the method described by Lapin (1973, p278):

$$\bar{x} - t_{\propto}\frac{s}{\sqrt{n}} \ll \mu \ll \bar{x} + t_{\propto}\frac{s}{\sqrt{n}} \quad (5.1)$$

Looking at "operating and administration costs" in "year 1", the confidence interval of -0.136 to 1.077 is calculated using the survey data feedback (shown in Table G2) as follows:

$$\bar{x} - t_{\propto}\frac{s}{\sqrt{n}} \ll \mu \ll \bar{x} + t_{\propto}\frac{s}{\sqrt{n}}$$

where:

$\bar{x}$ = 0.471

s = 1.179

n = 17

μ = zero (to test if benefits differ significantly from zero)

α = (1-C)/2, where C is the confidence interval. Therefore, for a 95% confidence interval α = 0.025

The degrees of freedom are calculated as *n*-1 = 16, and from the areas under the Student t distribution, $t_{0.025}$= 2.12 (for a two sided distribution, shown in Table G3).

Therefore, the example confidence interval is:

$$0.471 - 2.12\frac{1.179}{\sqrt{17}} \ll 0 \ll 0.471 + 2.12\frac{1.179}{\sqrt{17}}$$

$$-0.136 \ll 0 \ll 1.077$$

Table G2 Benefits calculation data ("year 1")

ERP Benefits Year 1	Company																		Statistics		Confidence Interval	
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	Mean	Std Dev	Lower	Upper
Financial Benefits																						
Operating and administration costs	-1	0	1	2	0	-2	0	1	-1	2	2	2	1	0	0	0	1		0.47	1.179	-0.136	1.077
Stock levels	0	0	0	1	0	2	1	1	-1	1	0	2	1	-1	0	0	0		0.41	0.870	-0.036	0.859
Turnover/Sales	0	0	1	0	0	0	0	1	0	2	0	0	1	0	0	1	0		0.35	0.606	0.041	0.665
IT operating costs	-1	-2	2	-2	-1	0	-2	0	-1	2	-1	1	1	-2	0	-1	0		-0.41	1.326	-1.093	0.270
Mean	**-0.50**	**-0.50**	**1.00**	**0.25**	**-0.25**	**0.00**	**-0.25**	**0.75**	**-0.75**	**1.75**	**0.25**	**1.25**	**1.00**	**-0.75**	**0.00**	**0.00**	**0.25**		**0.21**	**0.725**	**-0.167**	**0.579**
Internal Business Benefits																						
Manufacturing productivity and efficiency	0	0	0	1	0	0	2	0	-1	1	0	2	1	0	0	0	1		0.41	0.795	0.003	0.821
Resource utilization (Human & machine)	0	0	2	1	0	1	0	1	0	1	2	0	1	0	0	1	1		0.65	0.702	0.286	1.008
Enhanced business processes	-1	1	2	1	0	2	2	1	-1	2	3	2	1	1	0	2	0		1.06	1.144	0.471	1.647
Data/transaction processing time	0	2	1	2	0	2	0	1	-1	2	2	2	3	2	0	1	2		1.24	1.091	0.674	1.796
Inventory turns	0	0	0	0	0	1	1	2	-1	2	1	2	1	-1	0	0	1		0.53	0.943	0.044	1.014
Accuracy and timeliness of information	1	0	1	1	0	3	0	2	-1	2	3	3	3	0	1	2	0		1.24	1.300	0.567	1.904
Internal information sharing	1	2	1	1	0	1	1	3	0	2	2	3	2	1	1	1	0		1.29	0.920	0.821	1.767
Manufacturing lead times	0	0	0	1	0	2	1	0	0	2	0	2	1	0	0	0	1		0.59	0.795	0.179	0.997
Integration of applications	2	2	1	1	0	3	0	1	1	2	1	2	3	2	1	2	1		1.47	0.874	1.021	1.920
Improved decision making	2	0	2	1	0	1	1	2	1	2	1	2	2	-1	1	0	0		1.00	0.935	0.519	1.481
Vendor performance	0	-1	3	0	0	1	1	1	0	2	0	2	1	0	0	1	0		0.65	0.996	0.135	1.159
Mean	**0.45**	**0.55**	**1.18**	**0.91**	**0.00**	**1.55**	**0.82**	**1.27**	**-0.27**	**1.82**	**1.36**	**2.00**	**1.73**	**0.36**	**0.36**	**0.91**	**0.64**		**0.92**	**0.649**	**0.586**	**1.254**
Customer Benefits																						
Customer service	0	0	1	0	0	0	-1	1	0	2	0	2	1	0	0	1	0		0.41	0.795	0.003	0.821
On time shipments	1	0	1	0	0	1	1	1	0	2	1	0	1	-1	0	1	0		0.53	0.717	0.161	0.898
External information sharing	1	0	2	0	0	2	-1	1	0	2	2	2	1	0	0	0	0		0.71	0.985	0.199	1.212
Reduced service (delivery) lead times	0	0	1	1	0	1	0	1	0	2	1	0	1	0	0	1	0		0.53	0.624	0.208	0.850
Mean	**0.50**	**0.00**	**1.25**	**0.25**	**0.00**	**1.00**	**-0.25**	**1.00**	**0.00**	**2.00**	**1.00**	**1.00**	**1.00**	**-0.25**	**0.00**	**0.75**	**0.00**		**0.54**	**0.639**	**0.216**	**0.873**
Learning and Growth Benefits																						
Adherence to best practice work patterns	-1	0	2	1	0	2	3	2	1	1	0	2	3	1	1	2	0		1.18	1.131	0.595	1.758
Organisational learning	2	1	3	1	0	3	2	1	1	1	0	2	3	2	1	1	0		1.41	1.004	0.896	1.928
Effectiveness of employees	-1	0	1	0	-1	-1	-1	2	-1	1	2	1	3	0	1	1	0		0.41	1.228	-0.220	1.043
Roll out of a common vision	0	0	3	0	0	2	0	2	1	1	1	1	3	0	1	1	0		0.94	1.029	0.412	1.470
Mean	**0.00**	**0.25**	**2.25**	**0.50**	**-0.25**	**1.50**	**1.00**	**1.75**	**0.50**	**1.00**	**0.75**	**1.50**	**3.00**	**0.75**	**1.00**	**1.25**	**0.00**		**0.99**	**0.845**	**0.551**	**1.420**
Average Benefit Year 1 (Mean)	**0.11**	**0.07**	**1.42**	**0.48**	**-0.13**	**1.01**	**0.33**	**1.19**	**-0.13**	**1.64**	**0.84**	**1.44**	**1.68**	**0.03**	**0.34**	**0.73**	**0.22**		**0.66**	**0.630**	**0.340**	**0.988**

Table G3 t distribution table

One Sided	75%	80%	85%	90%	95%	97.50%	99%	99.50%	99.75%	99.90%	99.95%
Two Sided	50%	60%	70%	80%	90%	95%	98%	99%	99.50%	99.80%	99.90%
1	1.000	1.376	1.963	3.078	6.314	12.710	31.820	63.660	127.300	318.300	636.600
2	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	14.090	22.330	31.600
3	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	7.453	10.210	12.920
4	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.610
5	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	4.773	5.893	6.869
6	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.029	4.785	5.408
8	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	3.833	4.501	5.041
9	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	3.690	4.297	4.781
10	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.587
11	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	3.497	4.025	4.437
12	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.428	3.930	4.318
13	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.372	3.852	4.221
14	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.326	3.787	4.140
15	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.286	3.733	4.073
16	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.252	3.686	4.015
17	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.222	3.646	3.965

Lapin (1973)

Linear Regression – p167

Sample calculations are provided using the data in Table G4 to investigate the association between "operating and administration costs" and "business planning, vision & strategy"

Table G4 Sample survey data ("year 1")

Observation	Benefit (y)	CSF (x)
	Operating and administration costs	Business planning, vision & strategy
1	-1	4
2	0	4
3	1	3
4	2	4
5	0	4
6	-2	4
7	0	4
8	1	4
9	-1	3
10	2	3
11	2	4
12	2	4
13	1	4
14	0	3
15	0	4
16	0	4
17	1	3
Mean	**0.47**	**3.71**

Regression equation

The regression line is defined as:

$$\text{Benefits} = B_0 + B_1\text{CSF} + \text{error} \tag{5.2}$$

B_1 is calculated using the SLOPE function in MS Excel, corresponding to:

$$B_1 = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sum(x_i - \bar{x})^2} \tag{3.4}$$

$$B_1 = \frac{(4-3.71)(-1-0.47)+(4-3.71)(0-0.47)+(3-3.71)(1-0.47)\ldots.}{(4-3.71)^2+(4-3.71)^2+(3-3.71)^2\ldots.}$$

$$B_1 = -0.183$$

B_0 is calculated using the INTERCEPT function in MS Excel, corresponding to:

$$B_0 = \bar{y} - B_1\bar{x} \quad (3.3)$$

$$B_0 = 0.47 - (-0.183)3.71$$

$$B_0 = 1.15$$

"error" is calculated using the STEYX function in MS Excel, corresponding to:

$$error = \sqrt{\frac{1}{(n-1)}\left[\sum(y_i - \bar{y})^2 - \frac{[\sum(x_i-\bar{x})(y_i-\bar{y})]^2}{\sum(x_i-\bar{x})^2}\right]} \quad (3.5)$$

$$error = \sqrt{\frac{1}{15}\left[((-1-0.47)^2 + (0-0.47)^2 \ldots) - \frac{[(4-3.71)(-1-0.47)+(4-3.71)(0-0.47)\ldots]^2}{(4-3.71)^2+(4-3.71)^2 \ldots.}\right]}$$

$$error = 1.21$$

Combining these calculations results in the regression equation:

$$Benefits = 1.15 - 0.18CSF + error$$

Where error is 1.21

Linear regression t test

To apply the linear regression t-test to the sample data, the slope of the regression line, the degrees of freedom, the standard error of the slope, the t-score test statistic and the p-value of the test statistic are required:

Slope of the regression line

As calculated above, B_1= -0.183

Degrees of freedom

DF = n-2 = 15

SE (standard error)

SE is calculated in MS Excel using the formula:

$$SE = INDEX(LINEST(known\ y's, known\ x's,, TRUE), 2) \quad \text{(G3)}$$

This is equivalent to:

$$SE = \frac{\sqrt{\frac{\sum(y_i-\bar{y})^2}{(n-2)}}}{\sqrt{\sum(x_i-\bar{x})^2}} \quad \text{(G4)}$$

$$SE = \frac{\sqrt{\frac{(-1-0.47)^2+(0-0.47)^2+\ldots}{(15)}}}{\sqrt{(4-3.71)^2+(4-3.71)^2\ldots}}$$

$$= 0.6463$$

t-score

$$t = \frac{B_1}{SE} \quad \text{(G5)}$$

$$t = \frac{-0.183}{0.646}$$

$$= -0.278$$

Note: these t-score values were randomly checked (five per year) against a PASW TSTAT data output to confirm the calculation accuracy.

p-value

The t-score test statistic and the degrees of freedom are used to determine the p-value. In this example, the p-value is the probability that a t-score having 15 degrees of freedom is more extreme than 0.278. Since this is a two-tailed test "more extreme" implies greater than 0.278 or less than -0.278.

The TDIST function in MS Excel is used to calculate the p-value:

p-value = TDIST(abs(t-score), degrees of freedom, tails) *(G6)*

p-value = TDIST(abs(-0.278), 15, 2)

= 0.784

Coefficient of Determination

R^2 is calculated using the RSQ function in MS Excel, corresponding to:

$$R^2 = \left[\frac{\sum(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum(x_i-\bar{x})^2\sum(y_i-\bar{y})^2}}\right]^2 \quad (3.7)$$

$$R^2 = \left[\frac{(4-3.71)(-1-0.47)+(4-3.71)(0-0.47)\ldots.}{\sqrt{[(4-3.71)^2+(4-3.71)^2+\cdots][(-1-0.47)^2+(0-0.47)^2+\cdots]}}\right]^2$$

$$= 0.0053$$

APPENDIX H: PASW ANALYSIS OUTPUT

This section contains the PASW output tables displaying Cronbach's α and related statistics.

Table H1 PASW output – financial perspective ("year 1")

Financial Perspective (Year1)

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
.8235	8.404	2.89904	4

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	.206	-.412	.471	.882	-1.143	.172	4
Item Variances	1.068	.368	1.757	1.390	4.780	.389	4
Inter-Item Correlations	.356	.181	.659	.477	3.636	.025	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Operating_and_administration_costs	.3529	4.993	.384	.165	.634
Stock_levels	.4118	6.132	.351	.163	.640
Turnover	.4706	6.265	.584	.466	.565
IT_operating_costs	1.2353	3.691	.580	.503	.478

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.656	.688	4

Table H2 PASW output – financial perspective ("year 2")

Financial Perspective (Year 2)

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
6.1176	9.985	3.15995	4

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Minimum	Variance	N of Items
Item Means	1.529	1.294	1.765	.471	1.364	.046	4
Item Variances	.884	.596	1.007	.412	1.691	.038	4
Inter-Item Correlations	.600	.265	.842	.577	3.175	.036	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Operating_and_administration_costs	4.4706	5.015	.891	.828	.739
Stock_levels	4.3529	6.118	.610	.598	.864
Turnover	4.8235	7.154	.541	.435	.883
IT_operating_costs	4.7059	5.221	.819	.758	.773

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.861	.857	4

Table H3 PASW output – financial perspective ("year 3")

Financial Perspective (Year 3)

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
4.8824	11.610	3.40739	4

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	1.221	.706	1.824	1.118	2.583	.248	4
Item Variances	1.579	1.059	2.221	1.162	2.097	.239	4
Inter-Item Correlations	.283	.092	.518	.426	5.613	.018	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Operating_and_administration_costs	3.0588	8.434	.257	.086	.626
Stock_levels	3.4706	7.765	.311	.120	.595
Turnover	3.9412	7.684	.503	.295	.474
IT_operating_costs	4.1765	5.654	.527	.324	.414

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.608	.612	4

Table H4 PASW output – internal business perspective ("year 1")

Internal Business Perspective (Year 1)

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
10.1176	50.985	7.14040	11

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	.920	.412	1.471	1.059	3.571	.134	11
Item Variances	.938	.493	1.691	1.199	3.433	.120	11
Inter-Item Correlations	.388	-.059	.680	.740	-11.474	.038	11

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Manufacturing_productivity_and_efficiency	9.7059	45.346	.468	.861	.874
Resource_utilization	9.4706	46.265	.443	.945	.875
Enhanced_business_processes	9.0588	40.309	.645	.911	.863
Data_transaction_processing_time	8.8824	41.360	.601	.947	.866
Inventory_turns	9.5882	41.007	.752	.889	.856
Accuracy_and_timeliness_of_information	8.8824	36.485	.815	.825	.848
Internal_information_sharing	8.8235	42.154	.669	.946	.861
Manufacturing_lead_times	9.5294	43.890	.613	.897	.866
Integration_of_applications	8.6471	45.618	.390	.843	.878
Improved_decision_making	9.1176	44.110	.483	.923	.873
Vendor_performance	9.4706	42.640	.565	.685	.868

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.877	.875	11

Table H5 PASW output – internal business perspective ("year 2")

Internal Business Perspective (Year 2)

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
15.2941	33.596	5.79617	11

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	1.390	.824	2.000	1.176	2.429	.224	11
Item Variances	.775	.596	.985	.390	1.654	.016	11
Inter-Item Correlations	.299	-.169	.748	.917	-4.426	.051	11

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Manufacturing_productivity_and_efficiency	14.3529	27.993	.504	.889	.805
Resource_utilization	14.2941	30.971	.168	.767	.836
Enhanced_business_processes	13.5882	27.632	.587	.839	.797
Data_transaction_processing_time	13.5294	27.515	.555	.932	.800
Inventory_turns	14.4706	27.265	.602	.842	.795
Accuracy_and_timeliness_of_information	13.2941	27.096	.638	.908	.792
Internal_information_sharing	13.5882	27.882	.628	.830	.795
Manufacturing_lead_times	14.4118	28.632	.374	.753	.818
Integration_of_applications	13.2941	30.721	.257	.792	.825
Improved_decision_making	13.7647	28.441	.529	.737	.803
Vendor_performance	14.3529	26.743	.592	.814	.796

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.821	.824	11

Table H6 PASW output – internal business perspective ("year 3")

Internal Business Perspective (Year 3)

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
19.8235	46.154	6.79370	11

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	1.802	1.118	2.529	1.412	2.263	.307	11
Item Variances	.850	.404	1.235	.831	3.055	.057	11
Inter-Item Correlations	.376	-.365	.802	1.167	-2.195	.072	11

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Manufacturing_productivity_and_efficiency	18.5882	38.257	.535	.712	.871
Resource_utilization	18.4706	39.265	.472	.742	.875
Enhanced_business_processes	17.6471	43.243	.300	.746	.881
Data_transaction_processing_time	17.6471	37.993	.619	.756	.864
Inventory_turns	18.7059	37.221	.656	.850	.862
Accuracy_and_timeliness_of_information	17.3529	37.993	.686	.881	.860
Internal_information_sharing	17.7059	37.471	.757	.860	.856
Manufacturing_lead_times	18.7059	35.846	.682	.798	.860
Integration_of_applications	17.2941	45.721	-.008	.534	.897
Improved_decision_making	17.7059	35.721	.863	.851	.847
Vendor_performance	18.4118	36.007	.822	.879	.850

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.877	.869	11

Table H7 PASW output – customer perspective ("year 1")

Customer Perspective (Year 1)

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
2.1765	6.529	2.55527	4

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	.544	.412	.706	.294	1.714	.015	4
Item Variances	.627	.390	.971	.581	2.491	.062	4
Inter-Item Correlations	.558	.361	.731	.370	2.024	.015	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Customer_service	1.7647	3.941	.619	.469	.786
On_time_shipments	1.6471	4.243	.600	.553	.795
External_information_sharing	1.4706	3.140	.693	.506	.766
Reduced_service_lead_times	1.6471	4.243	.738	.630	.751

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.821	.835	4

Table H8 PASW output – customer perspective ("year 2")

Customer Perspective (Year 2)

Scale Statistics

Mean	Variance	Deviation	N of Items
4.4706	5.640	2.37481	4

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	1.118	.882	1.294	.412	1.467	.035	4
Item Variances	.708	.610	.816	.206	1.337	.007	4
Inter-Item Correlations	.327	.055	.556	.501	10.031	.035	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Customer_service	3.2353	2.941	.607	.429	.473
On_time_shipments	3.4118	3.507	.468	.313	.582
External_information_sharing	3.1765	3.779	.345	.325	.662
Reduced_service_lead_times	3.5882	3.882	.373	.270	.642

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.664	.661	4

Table H9 PASW output – customer perspective ("year 3")

Customer Perspective (Year 3)

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
5.9412	8.059	2.83881	4

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Minimum	Variance	N of Items
Item Means	1.485	1.118	1.765	.647	1.579	.072	4
Item Variances	.958	.610	1.191	.581	1.952	.061	4
Inter-Item Correlations	.379	.075	.790	.715	10.563	.055	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Customer_service	4.1765	4.404	.538	.290	.601
On_time_shipments	4.4118	4.382	.631	.657	.536
External_information_sharing	4.4118	5.757	.266	.147	.766
Reduced_service_lead_times	4.8235	5.404	.563	.635	.606

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.700	.709	4

Table H10 PASW output – learning & growth perspective ("year 1")

Learning and Growth Perspective (Year 1)

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
3.9412	11.434	3.38139	4

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	.985	.412	1.412	1.000	3.429	.183	4
Item Variances	1.213	1.007	1.507	.500	1.496	.052	4
Inter-Item Correlations	.464	.057	.614	.557	10.832	.045	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Adherence_to_best_practice_work_patterns	2.7647	6.441	.647	.470	.668
Organisational_learning	2.5294	7.765	.476	.554	.757
Effectiveness_of_employees	3.5294	7.265	.402	.519	.809
Roll_out_of_a_common_vision	3.0000	6.250	.802	.675	.589

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.767	.776	4

Table H11 PASW output – learning & growth perspective ("year 2")

Leaning and Growth Perspective (Year 2)

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
6.1176	9.985	3.15995	4

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	1.529	1.294	1.765	.471	1.364	.046	4
Item Variances	.884	.596	1.007	.412	1.691	.038	4
Inter-Item Correlations	.600	.265	.842	.577	3.175	.036	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Adherence_to_best_practice_work_patterns	4.4706	5.015	.891	.828	.739
Organisational_learning	4.3529	6.118	.610	.598	.864
Effectiveness_of_employees	4.8235	7.154	.541	.435	.883
Roll_out_of_a_common_vision	4.7059	5.221	.819	.758	.773

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.861	.857	4

Table H12 PASW output – learning & growth perspective ("year 3")

Learning and Growth Perspective (Year 3)

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
7.4706	11.015	3.31884	4

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	1.868	1.706	2.000	.294	1.172	.017	4
Item Variances	.983	.779	1.250	.471	1.604	.052	4
Inter-Item Correlations	.607	.443	.684	.240	1.543	.006	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Adherence_to_best_practice_work_patterns	5.5294	6.640	.769	.602	.794
Organisational_learning	5.4706	6.015	.684	.541	.831
Effectiveness_of_employees	5.6471	7.243	.630	.468	.847
Roll_out_of_a_common_vision	5.7647	6.066	.747	.563	.798

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.857	.861	4

Table H13 PASW output – ERP Time-Based BSC ("year 1") – perspective averages

ERP Time-Based BSC (Year 1) - using perspective averages

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
2.6553	6.356	2.52107	4

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	.664	.206	.985	.779	4.786	.131	4
Item Variances	.517	.408	.715	.307	1.751	.020	4
Inter-Item Correlations	.715	.558	.834	.276	1.494	.014	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Financial_Perspective	2.4494	3.550	.835	.769	.847
Internal_Business_Perspective	1.7353	3.746	.870	.773	.840
Customer_Perspective	2.1112	3.906	.809	.733	.862
Learning_and_Growth_Perspective	1.6700	3.580	.644	.450	.932

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.899	.909	4

Table H14 PASW output – ERP Time-Based BSC ("year 2") – perspective averages

ERP Time-Based BSC (Year 2) - using perspective averages

Scale Statistics

Mean	Variance	Deviation	N of Items
4.7135	4.754	2.18039	4

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	1.178	.676	1.529	.853	2.261	.141	4
Item Variances	.423	.278	.624	.346	2.246	.022	4
Inter-Item Correlations	.619	.497	.691	.195	1.391	.004	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Financial_Perspective	4.0371	2.665	.768	.620	.794
Internal_Business_Perspective	3.3235	3.186	.686	.510	.835
Customer_Perspective	3.5959	2.970	.699	.535	.825
Learning_and_Growth_Perspective	3.1841	2.378	.719	.526	.828

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.859	.867	4

Table H15 PASW output – ERP Time-Based BSC ("year 3") – perspective averages

ERP Time-Based BSC (Year 3) - using perspective averages

Scale Statistics

Mean	Variance	Deviation	N of Items
6.3747	6.232	2.49647	4

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	1.594	1.221	1.868	.647	1.530	.090	4
Item Variances	.575	.383	.726	.343	1.896	.026	4
Inter-Item Correlations	.599	.309	.757	.448	2.449	.024	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Financial_Perspective	5.1541	3.628	.579	.539	.849
Internal_Business_Perspective	4.5735	3.920	.788	.653	.766
Customer_Perspective	4.8894	3.498	.840	.726	.730
Learning_and_Growth_Perspective	4.5071	3.719	.570	.496	.850

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.841	.857	4

Table H16 PASW output – ERP Time-Based BSC ("year 1") – individual items

ERP Time-Based BSC (Year 1) - using individual items

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
17.0588	207.184	14.39388	23

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	.742	-.412	1.471	1.882	-3.571	.197	23
Item Variances	.954	.368	1.757	1.390	4.780	.157	23
Inter-Item Correlations	.397	-.280	.802	1.082	-2.869	.038	23

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Operating_and_administration_costs	16.5882	191.007	.454	.935
Stock_levels	16.6471	190.368	.669	.931
Turnover	16.7059	196.096	.631	.932
IT_operating_costs	17.4706	180.265	.707	.930
Manufacturing_productivity_and_efficiency	16.6471	197.743	.394	.935
Resource_utilization	16.4118	196.007	.544	.933
Enhanced_business_processes	16.0000	186.500	.620	.932
Data_transaction_processing_time	15.8235	189.404	.552	.933
Inventory_turns	16.5294	187.640	.722	.930
Accuracy_and_timeliness_of_information	15.8235	177.404	.811	.928
Internal_information_sharing	15.7647	189.441	.668	.931
Manufacturing_lead_times	16.4706	194.390	.548	.933
Integration_of_applications	15.5882	196.257	.415	.935
Improved_decision_making	16.0588	190.059	.630	.931
Vendor_performance	16.4118	186.257	.733	.930
Customer_service	16.6471	190.618	.726	.930
On_time_shipments	16.5294	194.765	.594	.932
External_information_sharing	16.3529	186.868	.718	.930
Reduced_service_lead_times	16.5294	194.515	.705	.932
Adherence_to_best_practice_work_patterns	15.8824	190.235	.502	.934
Organisational_learning	15.6471	195.493	.381	.935
Effectiveness_of_employees	16.6471	184.243	.643	.931
Roll_out_of_a_common_vision	16.1176	187.235	.671	.931

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.935	.938	23

Table H17 PASW output – ERP Time-Based BSC ("year 2") – individual items

ERP Time-Based BSC (Year 2) - using individual items

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
28.5882	141.382	11.89043	23

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	1.243	-.059	2.000	2.059	-34.000	.243	23
Item Variances	.845	.515	1.684	1.169	3.271	.067	23
Inter-Item Correlations	.291	-.372	.842	1.214	-2.263	.055	23

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Operating_and_administration_costs	27.4706	136.265	.150	.908
Stock_levels	27.4706	128.265	.503	.898
Turnover	28.0588	130.559	.629	.896
IT_operating_costs	28.6471	121.743	.627	.895
Manufacturing_productivity_and_efficiency	27.6471	130.243	.503	.898
Resource_utilization	27.5882	137.632	.131	.906
Enhanced_business_processes	26.8824	131.485	.471	.898
Data_transaction_processing_time	26.8235	130.904	.467	.899
Inventory_turns	27.7647	129.441	.556	.897
Accuracy_and_timeliness_of_information	26.5882	130.257	.525	.897
Internal_information_sharing	26.8824	131.610	.518	.898
Manufacturing_lead_times	27.7059	131.971	.369	.901
Integration_of_applications	26.5882	135.132	.306	.902
Improved_decision_making	27.0588	127.184	.752	.893
Vendor_performance	27.6471	123.868	.771	.891
Customer_service	27.3529	125.868	.725	.893
On_time_shipments	27.5294	135.765	.256	.903
External_information_sharing	27.2941	129.221	.593	.896
Reduced_service_lead_times	27.7059	134.596	.341	.901
Adherence_to_best_practice_work_patterns	26.9412	125.059	.688	.893
Organisational_learning	26.8235	126.654	.631	.895
Effectiveness_of_employees	27.2941	130.596	.578	.896
Roll_out_of_a_common_vision	27.1765	124.154	.725	.892

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.902	.904	23

Table H18 PASW output – ERP Time-Based BSC ("year 3") – individual items

ERP Time-Based BSC (Year 3) - using individual items

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
38.1176	193.735	13.91888	23

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	1.657	.706	2.529	1.824	3.583	.244	23
Item Variances	1.019	.404	2.221	1.816	5.491	.146	23
Inter-Item Correlations	.341	-.365	.847	1.212	-2.319	.050	23

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Operating_and_administration_costs	36.2941	181.596	.336	.921
Stock_levels	36.7059	179.096	.380	.920
Turnover	37.1765	179.779	.467	.917
IT_operating_costs	37.4118	171.382	.516	.918
Manufacturing_productivity_and_efficiency	36.8824	173.985	.686	.913
Resource_utilization	36.7647	182.191	.392	.919
Enhanced_business_processes	35.9412	188.059	.302	.919
Data_transaction_processing_time	35.9412	178.809	.551	.916
Inventory_turns	37.0000	177.500	.577	.915
Accuracy_and_timeliness_of_information	35.6471	176.993	.687	.913
Internal_information_sharing	36.0000	177.375	.684	.914
Manufacturing_lead_times	37.0000	174.250	.622	.914
Integration_of_applications	35.5882	189.257	.201	.921
Improved_decision_making	36.0000	172.375	.842	.910
Vendor_performance	36.7059	172.471	.826	.911
Customer_service	36.3529	172.868	.686	.913
On_time_shipments	36.5882	175.882	.630	.914
External_information_sharing	36.5882	177.132	.581	.915
Reduced_service_lead_times	37.0000	182.500	.503	.917
Adherence_to_best_practice_work_patterns	36.1765	178.279	.610	.915
Organisational_learning	36.1176	178.985	.451	.918
Effectiveness_of_employees	36.2941	174.721	.781	.912
Roll_out_of_a_common_vision	36.4118	176.382	.585	.915

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.919	.923	23