Characteristics of a successful new product development process for UK automotive component suppliers

This item was submitted to Loughborough University's Institutional Repository by the/an author.

Additional Information:

- A Doctoral Thesis. Submitted in partial fulfillment of the requirements for the award of Doctor of Philosophy of Loughborough University.

Metadata Record: https://dspace.lboro.ac.uk/2134/7066

Publisher: © Victoria M. Story

Please cite the published version.
This item is held in Loughborough University’s Institutional Repository (https://dspace.lboro.ac.uk/) and was harvested from the British Library’s EThOS service (http://www.ethos.bl.uk/). It is made available under the following Creative Commons Licence conditions.

For the full text of this licence, please go to: http://creativecommons.org/licenses/by-nc-nd/2.5/
CHARACTERISTICS OF A SUCCESSFUL NEW PRODUCT DEVELOPMENT PROCESS FOR UK AUTOMOTIVE COMPONENT SUPPLIERS

BY

Victoria M. Story

1998

Loughborough University Business School, Loughborough University
ACKNOWLEDGEMENTS

As the author, I wish to thank everyone who has helped me throughout my time at Loughborough University.

Special thanks and gratitude go to my supervisors. To Gareth Smith for all his advice, encouragement and support and to Jim Saker for all his support during the course of this study.

I would also like to acknowledge the help and support of the Motor Industry Research Association (MIRA), especially Geoff Callow for his constant enthusiasm and assistance. Thanks also go to the Economic and Social Research Council (ESRC) for the financial support to pursue my PhD studies.

I would also like to thank all those who, in one way or another, contributed to the completion of this study. I am lucky to have so many friends and colleagues who have always been available for support and advice. It is impossible for me to list everyone, however, special thanks go to Heidi Winklhofer for her support and constructive criticism, over the past year.

Finally, I would like to thank my family for their continuing support and encouragement in all that I do, but most of all Colin. Thank you for all your help, but most importantly for all your encouragement, love and understanding.
ABSTRACT

While previous research describes a broad set of factors that discriminate between new product success and failure, both the study findings and the models developed have tended to be very general. This has made it difficult for those involved in NPD to apply the lessons presented - "they are unable to relate them directly to their own situation" (Craig & Hart, 1992: 38). However, the way companies undertake the process activities during the development and launch of a new product has regularly been identified as being critical to the outcome of the NPD project (Booz et al, 1982; Cooper, 1979, 1980, 1990; Crawford, 1984; Maidique & Zirger, 1984).

This research fills a gap in the literature by explicitly focusing on the internal NPD process activities and project organisation within one industry, the Automotive Components Industry. The contribution of the research is to identify the critical success factors for the NPD process within Automotive Component firms, confirm whether different dimensions of success exist for this industry and identify whether the antecedents of successful NPD differ depending on the dimensions of success.

A model was developed, which was then tested using a six page postal questionnaire sent out to UK automotive component suppliers. 76 completed questionnaires were collected from 66 firms.

After a careful reliability and validity analysis of the measures used in the survey, a multiple regression analysis was undertaken to identify the critical success factors for each of the dimensions of success.

The findings from this research validate many ideas presented in the NPD literature. However, what is evident from this research is that new product success dimensions can not be treated together, and that 'average' models can be misleading. This may well have made it difficult for practitioners to relate the findings of previous studies to their specific development situations and could begin to explain why, despite all the research that has been undertaken in this area, failure rates are still so high.
# CONTENTS

## CHAPTER 1: INTRODUCTION

1.1 BACKGROUND TO RESEARCH .................................................. 1  
1.2 RESEARCH RATIONALE ....................................................... 2  
1.3 RESEARCH OBJECTIVES ..................................................... 6  
1.4 CHAPTER OUTLINE ............................................................ 7  

## CHAPTER 2: LITERATURE REVIEW

2.1 NEW PRODUCT DEVELOPMENT (NPD) DEFINITIONS .................. 9  
  2.1.1 THE NEED FOR NPD ............................................... 12  
  2.1.2 THE NPD PROCESS ................................................ 16  
2.2 ORGANISING FOR NEW PRODUCT DEVELOPMENT ................. 24  
  2.2.1 COMPANY CHARACTERISTICS .................................. 25  
  2.2.2 NPD STRATEGY .................................................... 27  
  2.2.3 MANAGEMENT ...................................................... 29  
2.3 SUCCESS AND FAILURE LITERATURE .................................. 31  
  2.3.1 REASONS FOR FAILURE ......................................... 32  
  2.3.2 KEYS TO NEW PRODUCT SUCCESS ............................. 34  
  2.3.3 SUCCESS VERSUS FAILURE ...................................... 35  
2.4 KEY ISSUES ................................................................. 46  
  2.4.1 THE SCOPE OF THE STUDY ...................................... 47  
  2.4.2 METHODOLOGICAL APPROACH .................................. 47  
  2.4.3 LEVEL OF ANALYSIS .............................................. 48  
  2.4.4 SUCCESS, FAILURE OR BOTH? .................................. 48  
  2.4.5 TYPES OF PRODUCT DEVELOPMENT .............................. 48  
  2.4.6 MEASURING SUCCESS ............................................ 49  
  2.4.7 PROCESS SECTION ................................................ 52  
  2.4.8 SUMMARY .......................................................... 54  
2.5 THE AUTOMOBILE INDUSTRY ............................................. 57
2.5.1 NPD IN THE AUTOMOBILE INDUSTRY 57
2.5.2 THE NEED FOR NPD IN THE AUTOMOBILE INDUSTRY 60
2.5.3 THE NPD PROCESS IN THE AUTOMOBILE INDUSTRY 61
2.6 SUMMARY AND IMPLICATIONS OF PAST RESEARCH 64

CHAPTER 3: EXPLORATORY

3.1 STUDY DESIGN 67
  3.1.1 KEY INFORMANTS INTERVIEWS 68
  3.1.2 INTERVIEW SCRIPT CONTENT 69
3.2 ANALYSIS STRATEGY 71
  3.2.1 WITHIN-CASE ANALYSIS 72
  3.2.2 CROSS-CASE ANALYSIS 72
3.3 QUALITATIVE FINDINGS 73
  3.3.1 CORPORATE CHARACTERISTICS 74
  3.3.2 WHAT TYPES OF NPD ARE UNDERTAKEN? 74
  3.3.3 SUCCESS MEASURES 76
  3.3.4 INTERNAL PROJECT VARIABLES 78
3.4 VALIDITY AND RELIABILITY OF QUALITATIVE DATA 84
35 SUMMARY 86

CHAPTER 4: CONCEPTUALISATION OF THE STUDY

4.1 A MODEL OF NPD PROCESS PERFORMANCE 88
  4.1.1 PROJECT ORGANISATION 91
  4.1.2 NEW PRODUCT IDEA SOURCE 92
  4.1.3 CORPORATE CHARACTERISTICS 92
4.2 FACTORS INFLUENCING NPD PERFORMANCE 93
  4.2.1 SUCCESS PERFORMANCE MEASURES 93
  4.2.2 NEW PRODUCT PROCESS 95
  4.2.3 NEW PRODUCT STRATEGY 96
  4.2.4 EXTERNAL ENVIRONMENT 97
4.3 SUMMARY

CHAPTER 5 : METHODOLOGY

5.1 PREVIOUS METHODOLOGIES

5.2 UNIT OF ANALYSIS

5.3 DATA COLLECTION

5.4 SAMPLE

5.5 QUESTIONNAIRE DESIGN

5.5.1 INFORMATION SOUGHT

5.5.2 TYPE OF QUESTIONNAIRE AND METHOD OF ADMINISTRATION

5.5.3 INDIVIDUAL QUESTION CONTENT / QUESTIONNAIRE ITEMS

5.5.4 FORM OF RESPONSE

5.5.5 QUESTION WORDING

5.5.6 QUESTION SEQUENCE

5.5.7 PHYSICAL CHARACTERISTICS OF THE QUESTIONNAIRE

5.6 QUESTIONNAIRE PRETESTING

5.6.1 INITIAL PRE-TEST

5.6.2 MAIL PILOT 1

5.6.2.1 Sample Selection and Administration

5.6.2.2 Efforts to increase the response rate

5.6.2.3 Response Analysis Of Mail Pilot 1

5.6.3 MAIL PILOT 2

5.7 EFFORTS TO IMPROVE RESPONSE RATE

5.8 MAIN SURVEY

5.8.1 FOLLOW-UP REMINDERS

5.8.2 RESPONSE ANALYSIS OF MAIN STUDY

5.8.2.1 Response Rate

5.8.2.2 Success Verses Failure Responses
CHAPTER 6: FIRM GENERAL AND NPD CHARACTERISTICS

6.1 SUCCESS MEASURES

6.2 GENERAL FIRM CHARACTERISTICS
   6.2.1 FIRM SIZE
   6.2.2 PRODUCT SECTORS

6.3 FIRM STRATEGY
   6.3.1 MARKET VERSUS TECHNOLOGY DRIVEN STRATEGY
   6.3.2 MASS VERSUS NICHE MARKETS

6.4 RESPONDENT PROFILE
   6.4.1 JOB FUNCTION
   6.4.2 MANAGEMENT LEVEL

6.5 NPD CHARACTERISTICS
   6.5.1 DURATION OF THE PROJECT
   6.5.2 SOURCE OF NEW PRODUCT IDEA
   6.5.3 JOINT VENTURE
   6.5.4 HIGH VERSUS LOW TECHNOLOGY

6.6 SUMMARY

CHAPTER 7: MODEL OPERATIONALISATION

7.1 ‘EFFECT’ VERSUS ‘CASUAL’ INDICATORS

7.2 SCALE DEVELOPMENT
   7.2.1 ITEM ANALYSIS
   7.2.2 COEFFICIENT ALPHA
   7.2.3 FACTOR ANALYSIS PROCEDURES

7.3 MODEL OPERATIONALISATION
7.3.1 PRODUCT ADVANTAGE 176
7.3.2 NON-PRODUCT ADVANTAGE 180
7.3.3 PROJECT ORGANISATION 180
7.3.4 MARKET ASSESSMENT 181
7.3.5 TECHNICAL ASSESSMENT 182
7.3.6 CONCEPT DEVELOPMENT AND EVALUATION 183
7.3.7 DEVELOPMENT PROGRAMME 184
7.3.8 PRODUCT TESTING AND VALIDATION 186
7.3.9 PROCESS TESTING AND VALIDATION 186
7.3.10 MARKET LAUNCH 187
7.3.11 COMPANY CHARACTERISTICS 187
7.3.12 MARKET POTENTIAL 188
7.3.13 MARKET COMPETITIVENESS 188
7.3.14 DIMENSIONS OF PERFORMANCE 189
7.3.15 SUMMARY 193
7.3.16 VALIDATION OF THE SCALES 195

7.4 MODEL ESTIMATION 196

7.5 OVERALL PERFORMANCE MODELS 201
7.5.1 FINANCIAL SUCCESS 201
7.5.2 CUSTOMER-BASED SUCCESS 201
7.5.3 PRODUCT-BASED SUCCESS 202
7.5.4 WINDOW OF OPPORTUNITY SUCCESS 202
7.5.5 SUMMARY 202

7.6 COPING WITH COLLINEARITY 204

7.7 PRINCIPAL COMPONENT ANALYSIS RESULTS 206
7.7.1 FINANCIAL SUCCESS 208
7.7.2 CUSTOMER-BASED SUCCESS 208
7.7.3 PRODUCT-BASED SUCCESS 209
7.7.4 WINDOW OF OPPORTUNITY SUCCESS 210
7.7.5 SUMMARY 211
APPENDIX 5.1 ITEMS USED TO MEASURE THE CONSTRUCTS
APPENDIX 5.2 ORIGINAL QUESTIONNAIRE
APPENDIX 5.3 PRE-TEST LETTER
APPENDIX 5.4 ORIGINAL COVER LETTER
APPENDIX 5.5 LETTER OF SPONSORSHIP FROM MIRA AND SMMT
APPENDIX 5.6 QUESTIONNAIRE FOR PILOT 1
APPENDIX 5.7 QUESTIONNAIRE FOR PILOT 2
APPENDIX 5.8 COVER LETTER FOR MAIN STUDY
APPENDIX 5.9 QUESTIONNAIRE FOR MAIN STUDY
APPENDIX 7.1 RESIDUAL PLOTS FOR FACTOR SCORE REGRESSION EQUATIONS
APPENDIX 7.2 RESIDUAL PLOTS FOR VARIABLE SELECTION REGRESSION EQUATIONS
LIST OF TABLES

3.1 - Corporate Characteristics.
5.1 - Issues to be Included in Measurement Instrument.
5.2 - Reasons for Non-Response.
5.3 - Reasons for Non-Response.
5.4 - Breakdown of Returned Questionnaires.
5.5 - Reasons for Non-Response.
5.6 - Reasons for Not Returning Information on Failure.
5.7 - Summary of T-test Results.
5.8 - Summary of Chi-square Results.
6.1 - Summary of the Performance Distributions.
6.2 - Summary of Firm Size Measures.
6.3 - Results of t-tests against Success.
6.4 - Chi-square Test for Sample Characteristics.
6.5 - Summary of Market Versus Technology Driven Strategy.
6.6 - Summary of Responses to Segmentation Strategies.
6.7 - Summary of Respondent Characteristics.
6.8 - Job Titles by Management Levels.
6.9 - Kruskal-Wallis One-way ANOVA for Management Level.
6.10 - Summary of Project Duration in Months.
6.11 - Summary of the source of New Product Idea.
6.12 - Mann-Whitney U Test of the Sources of the New Product Idea.
6.14 - Summary of Joint Venture Responses.
6.15 - Technology Level of the Product Developed.
6.16 - One-way ANOVA of Technology Levels.
7.1 - Overview of the Steps in the Analysis.
7.2 - Rotated Factor Matrix for Product Advantage Items.
7.3 - Characteristics of the Uniqueness Scale.
7.4 - Characteristics of the Performance Scale.
7.5 - Characteristics of the Cost Scale.
7.6 - Characteristics of the Distribution Scale.
7.7 - Characteristics of the Project Organisation Scale.
7.8 - Characteristics of the Market Assessment Scale.
7.9 - Rotated Factor Matrix for Technical Assessment Items.
7.10 - Characteristics of the Technical Assessment Scale.
7.11 - Characteristics of Concept Development and Evaluation.
7.12 - Rotated Factor Matrix for Development Programme Items.
7.13 - Characteristics of Design Scale.
7.15 - Characteristics of the Product Testing and Validation Scale.
7.16 - Characteristics of the Process Testing and Validation Scale.
7.17 - Characteristics of the Market Launch Scale.
7.18 - Characteristics of the Company Characteristics Scale.
7.19 - Characteristics of the Market Potential Scale.
7.20 - Characteristics of the Market Competitiveness Scale.
7.21 - Comparison of Alpha Values for Performance Dimensions.
7.22 - Comparison of Alpha Values for ‘Window of Opportunity’ Dimension.
7.23 - Rotated Factor Matrix for Performance Items.
7.24 - Characteristics of the Financial Performance Scale.
7.25 - Characteristics of the Customer-Based Success Scale.
7.26 - Characteristics of the Project-Level Success Scale.
7.27 - Coefficient Alphas for the Developed Scales.
7.28 - Outliers Identified for each Dependent Variable.
7.29 - Summary of the Four Overall Success Equations.
7.30 - Factor Analysis of Predictor Variables.
7.31 - Summary Statistics of Factor Scores for Financial Success.
7.32 - Summary Statistics of Factor Scores for Customer-Based Success.
7.33 - Summary Statistics of Factor Scores for Product-Based Success.
7.35 - Summary of Regression Equations for Four Factor Solutions.
7.36 - Summary Statistics for Financial Success Regression Equation.
7.37 - Summary Statistics for Customer-Based Regression Equation.
7.38 - Summary Statistics for Product-Based Success Equation.
7.39 - Summary Statistics for Respecified Product-Based Success.
7.41 - Summary of Regression Equations for Four Success Equations.
LIST OF FIGURES.

2.1 - Major Stages In New Product Development.
2.2 - A Typical ‘Stage-gate’ New Product Process.
2.3 - Strategic Objectives Attained By Successful New-Market Entries.
2.4 - Causes of New Product Failure.
2.5 - A Conceptual Model of the Factors Influencing New Product Outcomes.
3.1 - Analysis Strategy.
3.2 - Display Chart for Internal Development Project Variables.
3.3 - Stages in the Development Process Models of Firms Interviewed.
4.1 - Conceptual Framework.
4.2 - Antecedents of New Product Performance.
5.1 - Procedure for Developing a Questionnaire.
5.2 - Suggested Procedure for Developing Better Measures.
5.3 - Summary of Breakdown of Responses to Pilot 1.
5.4 - Summary of Breakdown of Responses to Pilot 2.
5.5 - Summary of Response Analysis of Main Survey.
5.6 - Number of Missing Variables per Case, Prior to Deletion.
5.7 - Number of Missing Variables per Case, After Deletion.
6.1 - Average Performance Distribution.
6.2 - Distribution of Full Time Employees.
6.3 - Distribution of Annual Sales Turnover for 1996.
6.4 - Distribution of Firms.
6.5 - Pie Chart of Market Versus Technology Strategy.
6.6 - Pie Chart of Mass Versus Niche Market Orientation.
6.7 - Competitiveness Index Distribution.
6.8 - Distribution of Job Function.
6.9 - Distribution of Management Level.
6.10 - Distribution of Project Duration in Months.
6.11 - Distribution of Product Technology Level.
7.1 - 'Effect Indicator' Model.
7.2 - 'Causal Indicator' Model.
7.3 - Product Advantage Construct Model.
CHAPTER 1

INTRODUCTION

New Product Development (NPD) is defined as the overall process of strategy, organisation, concept generation, product and marketing plan creation and evaluation, and commercialisation of a new product (Crawford, 1997). Although considerable effort has been devoted to identifying the factors that contribute to new product success and failure, plenty of work remains to be done in this area (Craig and Hart, 1992; Montoya-Weiss and Calantone, 1994; Wind and Mahajan, 1997).

The remainder of this chapter will provide the background to the research, the rationale for the research and its objectives and finally, provide an outline of the chapters to follow.

1.1 BACKGROUND TO RESEARCH

While previous research studies describe a broad set of factors that discriminate between new product success and failure, such as top management commitment, introducing a unique and superior product, or marketing synergy, the findings and the models developed have tended to be very simplified (Craig and Hart, 1992). Much past and current research remains exploratory in nature, focused on the identification rather than explanation of factors (Cooper & Kleinschmidt, 1987b; Montoya-Weiss and Calantone, 1994).

Common designs should have developed to provide a replicative, integrated scientific approach for advancing the field. However, this has not been the case. What is found is a wide variation in research designs, methods and operationalisations of the dependent and explanatory variables used to study new product performance (Montoya-Weiss & Calantone, 1994). This persistent exploratory nature of the empirical New Product Development research is due to the lack of organised synthesis of past research (Montoya-Weiss & Calantone, 1994) and may well provide some explanation as to why, despite the very consistent findings of many past studies, failure rates are still high and have shown little improvement since studies were first done (Urban and Hauser, 1993; Kleinschmidt and Cooper, 1995).
Craig and Hart (1992) suggest that these consistent results could be explained by the fact that researchers are clearly influenced by previous studies from which they derive their variable set, perhaps to the exclusion of other important factors. They go on to suggest that, as a consequence, very similar variables are examined, regardless of whether they are appropriate, leading to a series of highly inter-correlated results. A study that gives weight to this concern was undertaken by Link (1987), who used open-ended questions to ask respondents to cite any additional critical success factors and unearthed three new factors which had not previously been identified.

A large number of empirical studies (reviewed in Chapter 2) have identified that how companies carry out the activities during the development and launch of a new product is critical to the outcome of the NPD project (Booz et al 1982, Cooper 1979b, 1980, 1990, Crawford 1984, Maidique & Zirger 1984). However, contrary to this importance, a study by Cooper and Kleinschmidt (1995) identified that “The new product process is very much in trouble, plagued by errors, omissions and doubtful quality of execution. The time is ripe to look at one’s innovation process: dissect it to uncover the root causes of these quality deficiencies; then re-engineer the process building in quality-of-execution and a strong market orientation; ...” (1995 : 334).

These observations certainly lend support to the idea that not enough is known at present about the issues surrounding the development of new products (Lowe & Hunter, 1991).

1.2 RESEARCH RATIONALE

Definition of Success

Key to understanding the issues related to success and failure of new products is being able to measure ‘success’ and ‘failure’. Past literature identifies that there is very little consensus over how best to operationalise “success” (Hart 1993). Traditionally success has been measured on a unidimensional axis and typically in financial terms (Cooper, 1987c). More recently, other ‘non-financial’, subjective measures such as ‘innovativeness’, customer satisfaction, quality and employee development have also been used. There has been much debate about the appropriateness of particular measures, and about the best way to combine ‘financial’ and ‘non-financial’ measures.
This use of different success/failure measures and the “preoccupation with financial results and financial gauges of success” has made it difficult to draw generalisations across investigations (Cooper & Kleinschmidt, 1987c: 215).

**Dimensions of Success**

An important issue that has arisen from this look at how success and failure is defined is that studies have identified more than one dimension of success (Cooper and Kleinschmidt, 1987c; Griffin and Page, 1993, 1996). Research undertaken by a PDMA (Product Development and Management Association) task force confirmed that project success consists of three independent dimensions: consumer-based, financial and technical or process-based success (Griffin and Page, 1993). This report went on to identify 16 “core” measures of success, both project and firm level measures, which were common to both practitioners and the literature. After further research, Griffin and Page (1996) go on to suggest that these measures are the most comprehensive set of post launch measures available. However, the identification of independent dimensions of success has caused researchers to question whether the critical success factors (c.s.f.) identified by previous research are appropriate, as Cooper and Kleinschmidt (1987c: 217) state “Since there are different dimensions of success, then conceivably, there could be three independent sets of success factors”.

The possibility of different measures reflecting different success factors has not been fully explored by past literature (Craig and Hart, 1992).

Therefore, there is a need to confirm that the measures used in future studies to gauge the performance of NPD projects are both comprehensive and, due to the contingent nature of new product development (Craig and Hart, 1992), appropriate for the industry under investigation. There is also a need to study individual success dimensions in order to confirm, or otherwise, the suggestion that the critical success factors differ for each of these dimensions of success.

**Focus on Internal Process Variables**

The literature indicates that the success or failure of new products is under managers’ control (Calantone et al., 1996; Montoya-Weiss and Calantone, 1994). Cooper (1979a) identified that environmental variables “do not play a critical role in deciding new product success” (1979a:127). In a meta-analytic review of the literature,
Montoya-Weiss and Calantone (1994) conclude that the factors most strongly associated with new product success are controllable and that the factors over which managers exert some level of control offer the greatest opportunity for improving the success rate of new products. However, not enough is known about these managerially controllable factors (Calantone et al., 1996). Many previous studies have used the simplistic process models from which to develop the questions asked and this could help to explain the lack of implementation by practitioners who find it hard to apply the lessons presented in the literature because “they are unable to relate them directly to their own situation” (Craig and Hart, 1992:38).

Therefore, this research focuses on aspects of new product development that managers can control, the development process activities, in greater detail, in order to identify the specific activities that will improve practitioners chances of developing successful new products depending upon which type of success they are striving to achieve.

‘Averaging’ of Past Research Findings Over Country and Industry Boundaries

Another suggestion has also been put forward as to why, despite the similarity of previous study findings, failure rates are still so high (Cooper and Kleinschmidt, 1993a; Lilien and Yoon, 1989). Many researchers focus their investigations on a variety of industries, often because difficulties in finding a large enough sample size within any one industry. Cooper and Kleinschmidt (1993a) suggest that the similarity in the results could be a consequence of “averaging” of results across industries and country boundaries.

What this means is that, in attempting to provide generalisable results, researchers have been producing "average" results which practitioners then find hard to relate to their particular product development context (Craig and Hart, 1992). The suggestion is that researchers should adopt a more contingent approach to studying the factors affecting new product development success and failure (Craig and Hart, 1992).

Therefore, for this study one business area, was chosen in order to minimise inter-industry and inter-market effects that have tended to detract from many previous success/failure studies (Cooper & Kleinschmidt 1993a, Lilien & Yoon 1989).
The Automotive Components Industry

Many researchers have identified that the automotive industry is especially important because it is the single largest industrial sector in the world economy and has traditionally been at the forefront of establishing patterns of work (Helper, 1991; Lamming, 1993; Womack et al., 1990). The UK automotive components industry was chosen because it provides an interesting area for study due to the significant changes taking place in the structure of the Automotive Industry as a whole. Suppliers are becoming increasingly important in the eyes of manufacturers (Bertodo, 1991), especially as new buyer-supplier relationships are established (Wells and Rawlinson, 1994). Car makers 'have sought to cut costs, shorten new product lead times and generally make life easier for themselves by devolving to suppliers much of the burden of designing and manufacturing entire component systems' (Simonian, 1998). Much of this change has been as a consequence of the Japanese automotive industry, who's apparent success in terms of both production (Womack et al., 1990) and new product development (Clark et al., 1987) has caused Western manufacturers to begin changing the way they operate and the way they deal with suppliers. These changes are driving suppliers to focus on product design and development as a basis for competition (Phelan, 1997). Vehicle Manufacturer's (VM's) are moving towards a more systems-oriented approach in which a limited number of systems suppliers or systems integrators - with design, engineering, and other advanced capabilities - supply fully assembled and tested modular systems (Wells and Rawlinson, 1994).

Successful new product development brings important benefits to companies in terms of sustained competitive advantage and profitability (Hart and Craig, 1993). The projected global market for systems suppliers to the vehicle industry is expected to reach 80,000 million by 2002, growing steadily from the current 50,000 million (Foresight Vehicle Programme, 1998). Therefore, component suppliers are now being required to carry out more of the new product development work which they have not previously had to do, and their ability to do this will be critical to their survival in the industry (Lamming, 1993; Ponticel, 1998).

Other factors influencing the industry include globalisation, new technology, endless cost reductions to meet car manufacturer's targets and the regulators driving the
industry to meet tougher environmental challenges (Foresight Vehicle Programme, 1998).

However, the news for the European automotive industry has not been particularly good. Two reports in 1993 show that the automotive industry in Europe is trailing its' international counterparts in terms of both competitiveness and performance (Boston Consulting Group, 1993; Anderson Consulting, 1993). A study by Oliver et al., (1996) concludes that within Europe there are large variations in performance from country to country and suggest that further research into national competitiveness and firms’ specific practices would be useful.

In order to meet these challenges, component suppliers must develop robust new product development processes that enable innovation to be quickly and effectively exploited (Wells and Rawlinson, 1994; Simonian, 1998).

1.3 RESEARCH OBJECTIVES

The present study attempts to fill a gap in the literature by explicitly focusing in detail on the internal project development process activities and their effects on performance.

The aim of the study is to examine the way automotive component suppliers develop new products in order to identify characteristics of a successful new product development process that are unique to each dimension of success.

The study's specific objectives are:

1. to gain a more complete understanding of the detailed internal development process activities in the automotive components industry;

2. confirm whether the different dimensions of success identified by previous research exist in the automotive components industry;

3. ascertain the critical success factors (c.s.f.) for each of the identified dimensions of success; and

4. determine whether the c.s.f. differ depending on the dimension of success.

Answers to these research objectives will help advance the knowledge concerning the internal project variables that correlate with new product success in the Automotive Components Industry. In essence this research attempts to go beyond a purely
descriptive investigation through the development of theoretically-driven research hypotheses to extend the knowledge of new product success by:

- exploring the issue of success definition and measurement to provide further insights into this complex and much debated area;
- examining how the internal 'controllable' project variables are related to the eventual NPD outcome;
- examining the impact of environmental factors as moderators of performance.

This research builds upon past studies by incorporating these issues to provide a more sophisticated way of probing the relationship between success and internal development processes activities for automotive component suppliers. It also provides important managerial guidelines concerning which activities firms should focus more of their resources on depending on which success outcome is desired.

1.4 CHAPTER OUTLINE

The rest of the thesis is structured as follows:

Chapter two provides a review of the literature relevant to the development of the research. Firstly, NPD definitions are reviewed, then specific important success/failure studies are discussed. Next, an examination of important methodological issues is provided, followed by a review of NPD in the automotive industry. The chapter concludes with a summary of the important findings and implications for the research.

Chapter three presents the methodology used to undertake the exploratory, qualitative interviews and the findings of these in-depth interviews.

Chapter four presents the conceptualisation of the study which provides the theoretical basis for the main empirical investigation. A model of the NPD process activities is presented and the author provides justification for each of the linkages introduced and hypotheses to be tested.

Chapter five describes the research methodology utilised, including the data collection method, the sampling frame, the questionnaire development and the study implementation.
Chapter six aims to describes the general and NPD characteristics of the firms and identify whether any of these variables have a moderating effect on the outcome of the projects. It also provides a profile of the respondents.

In chapter seven, eighteen summated scales are constructed using scale development techniques and then the model is operationalised using multiple regression techniques for each of the performance dimensions identified.

Finally, chapter eight summarises all the findings and draws conclusions pertinent to both academics and practitioners. The limitations of this work are discussed and recommendations for future research are made.
"Innovation is the specific tool of entrepreneurs, the means by which they exploit change as an opportunity for a different business or a different service. It is capable of being practiced. Entrepreneurs need to search purposefully for the sources of innovation, the changes and their symptoms that indicate opportunities for successful innovation. And they need to know and apply the principles of successful innovation" (Drucker, 1985).

An extensive literature search was conducted in several disciplines, including, marketing, organisational behaviour and engineering. An enormous amount of literature was found, in which researchers have attempted to identify the determinants of new product performance, both as studies of best practice and rich qualitative insights (e.g. Womack et al, 1990). First, the chapter looks at general NPD literature, including the definition of and need for NPD. Then, the processes put forward for undertaking NPD and the organisational issues surrounding NPD are discussed. Following this, specific important success/failure studies are reviewed and NPD issues and practices within the Automotive Industry are reviewed. The chapter concludes with a summary of the important findings and implications for the research.

2.1 NEW PRODUCT DEVELOPMENT (NPD) DEFINITIONS

NPD is not consistently defined, with numerous different definitions being used, all with varying emphasis. Added to this is the fact that New Product Development is not the only term used to describe the process by which a new product is developed. The particular terminology used tends to depend on the business area in which it is used, although not always (Craig and Hart, 1992). "New Product Development" is the term most commonly used in marketing and management, (Booz et al., 1982; Dolan, 1993; Drucker, 1985); "Design" in engineering (Hollins and Pugh, 1990); and R&D people invariably refer to the term "innovation" (Parker, 1985; Rothwell et al., 1974).
Some common definitions highlighted by Souder (1987) are: a creative process in which two or more existing things are combined in some novel way to produce a unique new thing; the invention and implementation of a new device; the sequence of events from the generation of an idea to its adoption; the adoption of a change that is new to the organisation, group, or society.

NPD is clearly about new ideas and change, but how researchers define a "new product" has not been consistent. The term "product" now generally incorporate services as well. Douglas et al. for their study (1983:1) defined a product as, "anything which requires marketing to anybody, ... covering both goods and services, in the widest sense of each". Gruenwald (1985) also suggests that a new product means a new service - or a 'package' of services or of products and services.

Parker (1985) in his definition, "the creation of a new idea, often an invention, together with its progression to the marketing of a new material, process or system", which continues, "innovation implies a discontinuity sufficiently great to merit an examination of its possible effects on the company's strategies, structure and attitudes", clearly makes a distinction between innovation and what he termed "evolutionary developments". Parker's view was that innovation was about radical change, not a progression via incremental steps, which was high risk and demanded exceptional skills and determination. Souder (1987) also refers to innovation as "a high-risk idea that is new to the sponsoring organisation, and which the organisation believes has high profit potential or other favourable commercial impacts for them". In Souder's research study each firm was free to dimension risk and financial welfare in any way it chose. The approach used and it's findings substantiated the viewpoint that innovation is situationally determined.

There are others, however, that believe that defining innovation purely as "radical change" is restrictive and some suggest that it is often the case that radical changes in technology are better described as inventions. When analysing what actually constitutes a new product, Baker (1991:267) also discusses the role of inventions in NPD stating that, "It is possible to distinguish a spectrum of newness ranging from an invention, (using Mansfields’ (1966) definition of an invention, 'a prescription for a new product or process
that was not obvious to one skilled in the relevant art at the time the idea was generated') to a minor change in an existing, widely known product."

These views highlight both the fact that NPD is generally seen to include many types/degrees of innovation, as well as providing an idea of what is meant by "new", which can be problematic in that there is no consistency in the "newness" of products studied. An additional problem is that many of the researchers have neglected to qualify how "new" the new products are that they have studied (Montoya-Weiss and Calantone, 1994) and of those that have been specified, definitions vary considerably. However, what is clear is that there are many different types of new products.

Cooper (1993) suggests that "Newness" can be defined in two senses:

- new to the company, in the sense that their firm has never made or sold this type of product before, but other firms might have.
- new to the market or "innovative": the product is the first of its kind on the market.

Booz et al. (1982) categorised new products into six groups based on their degree of newness, identified from a survey of the new product development practices of 700 U.S. Corporations. These are:

- New to the world products; new products that create an entirely new market. (10%)
- New product lines; new products that allow a company to enter an established market for the first time. (approx. 20%)
- Additions to existing product lines. (26%)
- Improvements in, or revisions to, existing products. (26%)
- Repositionings; existing products that are targeted to new markets or market segments. (7%)
- Cost reductions. (11%)

These have been validated by other researchers, including Kotler and Armstrong (1994:312), whose definition shows, "by new products we mean original products, product improvements, product modifications, and new brands that the firm develops through its own research and development efforts".
Souder (1987) suggests that a product can be new in many different ways: lower prices; greater convenience; improved performance; newer appearance; or new markets, and sees the key as: "newness to the sponsoring organisation" i.e. they have not had one like it before. He believes this is situationally determined based upon the perceptions of the people within a company. Kotler (1994) also agrees that "newness" is all about perceptions, however, he suggests it is about the perceptions the customer has, rather than internal perceptions. Jobber (1998) also identifies that the degree of risk and reward associated with each of these categories varies. The degree of newness of a product is important in that it affects the NPD process that companies will use for each project (Craig and Hart, 1992), and must, therefore, be considered when undertaking NPD research.

2.1.1 THE NEED FOR NPD

Competition is intensifying in many industries (Griffin, 1993; Hayes et al., 1988; Womack et al., 1990). A company can no longer rely solely on its existing products to remain competitive due to the increasing uncertainty of the external environment, characterised by "shorter product life cycles; heightened competition from home and abroad; maturing industries and flat markets; and the quickening pace of technological developments" (Cooper and Kleinschmidt, 1987c:216).

There have been many factors highlighted in research studies that are said to be creating this uncertainty in the external environment (Urban and Hauser, 1993; Cooper and Kleinschmidt, 1987c; Dolan, 1993; Kotler, 1994; Toffler, 1980; Towner, 1994), the most important of which are discussed below.

Basic marketing theory states that a product undergoes a product life cycle (PLC) of introduction, growth, maturity, and finally decline. This means that there is a constant need to innovate in order to surplant the income that will no longer be generated by current products. This is becoming increasingly important as product life cycles become shorter (Kotler, 1994).
The pressure to achieve financial goals can initiate new product development. Urban & Hauser (1993) point out that, new product activity is linked intimately to financial planning and the need for sound earnings growth is one of the most important forces impelling new product development. This is also borne out in the Booz et al. (1982) study, where they found that managers predicted that 40% of firms' profits over the next five years would come from new products.

One of the most important factors accounting for the decline of some products is the rapid technological changes which are taking place. The pace of these changes has increased, and is likely to continue increasing for some time to come (Toffler, 1980), putting extreme pressure on organisations to "innovate or die" (Johne & Snelson, 1987). These changes also present opportunities for firms as they open up many new markets, and for those that create new products to satisfy these new markets the rewards can be high.

Competitive action can also create the need to innovate. When competitors introduce new products, a firm must react to remain competitive, although, it is even better to be proactive to stay ahead of the competition. This requires the company to be continually looking to develop new products. This competitive pressure has been heightened by the increase in global trading, creating even greater threat of entry to firms as traditional markets become more accessible to foreign competitors. However, globalisation has also presented many opportunities for firms in terms of the new markets which they can now access.

Another factor creating uncertainty is that consumers are becoming more sophisticated and informed and are now demanding products that better fit their needs. This requires firms to be more market oriented, looking for areas where market needs are not being fulfilled and then developing products that are tailored to these needs, rather than the traditional 'technology-push' approach where organisations developed new products and then tried to find a market in which to sell them.

In recent years some firms have attempted to update or increase their product ranges by merging with or acquiring other businesses. Some suggest this is a means for getting
around the high costs and risks associated with NPD (Kotler 1994). However, Johne and Snelson (1987) disagree, and suggest that although the common perception that, "acquisition can appear an attractive route when comparing with the risks of new product development" and is seen as a quicker and cheaper method of growing, they believe that it is a "quick fix" solution that is equally demanding in terms of the skill requirements to successfully merge different managerial and business skills. It also has other risks attached, such as, government regulations. They go on to state that NPD can be made into a more cost-effective and attractive route by the careful management of risks and costs. Firms that are high achievers in new product development deal head-on with the risks and costs by carefully developing a strategy for new product development based on the company's inherent strengths.

It is, therefore, now widely acknowledged that NPD is crucial to maintain a healthy organisation, and there are many contributions to literature on the corporate importance of carrying out new product development (e.g. Calantone et al., 1996; Von Hippel, 1988). Cooper (1993:4) states that "New products account for a staggering 40 percent of company sales on average".

A survey of 700 firms (60% industrial, 20% consumer durables, 20% consumer non-durables) by Booz et al. (1982) found that over a five year period new products accounted for 28% of the companies' growth. A study in 1990 by Wind, Mahajan, and Bayless, sponsored by the Marketing Science Institute, found that 25% of current sales were derived from new products introduced in the last three years and Power (1993) identifies that companies that lead their industries in profitability and sales growth get 49% of their revenue from products developed in the past five years.

However, innovation can also be very risky and failure can prove costly (Baker, 1996). Kotler et al., (1996), identify that new product development is very expensive, for example, Tate and Lyle spent 150 million on developing a new sugar substitute. What adds to the cost is that it takes a large number of raw ideas to produce one commerically successful new product (Booz et al., 1968) and the further along the development process the project gets before a 'stop' decision is made, the higher the costs (Cooper, 1993). An
estimated 46% of all NPD resources by U.S. firms studied were spent on products that were cancelled or failed to yield an adequate financial return (Booz, et al., 1982). This study revealed that for every seven new product ideas, about four enter development, 1.5 are launched, and only one succeeds. A more recent investigation suggests that the attrition rate of new product projects is even worse: eleven new product ideas, three enter the development phase, 1.3 are launched, and only one is a commercial success (Page, 1993). The Foresight Vehicle Programme (1998) has identified that for the automotive industry the number of ideas for one new product success has, typically, been around 3,000 and that, as the technology required for competitive advantage increases, this ratio could well increase.

NPD also takes time, therefore, the uncertainty or unpredictability of the market environment can also increase the risk of failure. Projects are always in doubt during their development (Ronkeinen, 1983).

However, this organisational importance attached to NPD is inconsistent with the findings of studies which have found the nature of the competitive situation to only be weakly related to success (Cooper, 1979a, 1979b, 1980, 1981; Cooper and Kleinschmidt, 1993a, 1993b).

Paradoxically, the level of importance attributed to new product development does not seem to be matched by the level of success (Craig & Hart, 1992) and despite all the research that has been carried out in this field, the failure rate still remains high (Urban and Hauser, 1993). However, just how high, is blurred by the variability amongst the reports of typical new product failure rates. According to Crawford’s (1979) thorough review of these often quoted estimates of failure in NPD, which range from 20% to as high as 90%, the true failure rate is around 35%. Booz et al. (1982) also reported failure rates of between 30 and 40%. They also estimate that 46% of the resources that firms spend on the conception, development, and the launch of new products are spent on products that either fail commercially in the marketplace or never make it to the market. More recently, a study carried out by Cooper (1992) found that 33% of new industrial products fail at launch. Yet, despite the variability in the reported failure rates, it is
widely held, as Wind and Mahajan (1981) have commented, that the percentage of new product failures is still alarming. This is backed by Cooper (1995) who again highlights that, despite all the studies that have been carried out in this area, new products continue to fail or under-perform at an alarming rate of around 60%.

2.1.2 THE NPD PROCESS

A useful general definition of a New Product Development Process is provided by Cooper (1994:3):

"a formal blueprint, roadmap, template or thought process for driving a new product project from the idea stage through to market launch and beyond."

Souder’s (1987) definition: "any system of organised activities that transforms a technology from an idea to commercialisation, although not necessarily to ‘commercial success’", also indicates that the new product development process is all about the movement of a new product project from conception to commercialisation via planned and organised activities.

Craig & Hart (1992:20) suggests that "the process of new product development involves the activities and decisions from the time when an idea is generated (from whichever source) until the product is commercialised (i.e. launched into the market)" - highlighting that decisions also play a part in the NPD process.

All the above three definitions seem to suggest that the process generally begins with a concept and ends with the launch of a new product.

Numerous normative and descriptive models of the NPD process have been developed from the domains of marketing, management, design and engineering. In 1982, Booz, Allen and Hamilton put forward a seven step new product development process identifying the activities involved in bringing new product ideas to the marketplace. This process differed from their earlier model with the addition of ‘strategy’ as a first step. These steps were: NPD Strategy; Idea Generation; Screening and Evaluation; Business
Analysis; Development; Testing; and Commercialisation. The authors also noted that the various stages were becoming more iterative.

Kotler (1994) also suggests a unidirectional development process consisting of eight major steps: idea generation; screening; concept development and testing; marketing strategy; business analysis; product development; market testing and commercialisation (see Figure 2.1).

**Figure 2.1 - Major Stages In New Product Development**

![Figure 2.1 - Major Stages In New Product Development](image)


Douglas et al. (1983) point out that a systematic/sequential approach helps bring control to a complex and risky process, making it more efficient, and the framework it provides
ensure that people know what needs to be done, by whom, by when, as well as saving time and effort and avoiding duplication. However, this 'over the wall' approach, where each department carries out its stage and then hands the project on to the next department, also has deficiencies. The process is slow and there is a lack of communication between departments leading to problems of influence and roadblocks created by the functional fiefdoms. This is also backed up by Kotler et al. (1996:528) who state that the sequential development process is too slow and can "cost companies potential sales and profits at the hands of more nimble competitors".

Crawford (1997) clearly recognises these problems in his model where the development process is shown as three parallel activities during which marketing and technical departments interact to develop and evaluate the product concept.

Cooper (1983) states that an ideal process model would satisfy four main requirements: it must be sufficient in detail to act as an action guide to managers, yet not be too pedantic so as to discourage its use; it must be strongly market oriented, building in market research and market planning throughout the process; the model must be multi-disciplinary and foster internal communication among key groups; finally it must recognise the high failure rates and risks associated with new products by building in evaluation and bail out points throughout the process. Cooper (1983) proposed a flow model approach to new product development to meet these requirements. His model also clearly demonstrates the need for parallel activity especially between the marketing and technical activities.

Cooper's model, however, only takes into account activities carried out within the firm. Utterback et al (1976) examined the relationship between outside influences and the firm's innovation process, and found that nearly a quarter of the ideas for innovation originated from outside the firm making the external variables an important aspect of the process. Souder (1987) proposed a broad model to take into account additional environmental and organisational variables which was oriented towards the strategic management of new product development. Johne and Snelson (1987) suggest using the value chain concept, developed by Michael Porter (1985), to analyse the benefits
customers are looking for. They stress the importance of not only analysing the customer requirements, but also the 'goodness of fit' between these requirements and the manufacturers capabilities. They also found that some firms had gone even further in finding ways for identifying profitable potential product development opportunities. On top of paying close attention to both customer preferences and their own manufacturing possibilities they also consider potentially profitable relationships with their suppliers. This has been termed 'effecting synergy between value chains' by Mark O'Hare (1988) and again highlights the importance of outside influences and the opportunities they provide.

More recently Cooper & Kleinschmidt (1993c) identify that some companies had adopted formal new product processes, which they termed 'Stage-gate' systems and suggest that these were one solution to the problems of previous models. Figure 2.2 provides a general model of the 'Stage-gate' system.

**Figure 2.2- A Typical 'Stage-gate' New Product Process**

![Stage-gate Process Diagram](image)


The typical 'stage-gate' model is a roadmap from idea to launch consisting of identifiable and discrete stages preceded by review points or 'gates'. It also incorporates lessons learned from the studies carried out into the factors associated with success.
The 'stage-gate' models, therefore, also has:

- a cross-functional, project team approach,
- marketing and manufacturing as integral parts of the product development process,
- decision points that are also cross-functional, to ensure commitment from all parties,
- a holistic process,
- much more emphasis on up-front, pre-development work,
- a much stronger market orientation,
- parallel/concurrent processing,
- sharper decision points with clear go/kill criteria, not just, is it on budget and is it on time?

These processes address the wisdom of continuing from a business perspective, featuring tough gates with rigorous criteria and metrics.

Cooper noted that implementation results had generally been positive and identified five specific improvements, in rank order:

1) Much better cross-functional teamwork
2) Less recycling and rework
3) Earlier detection of failures
4) Better launch
5) Shorter elapsed time due to better homework, more multi-functional inputs, sharper market and product definition, and less recycle.

However, Cooper also identified six problems that these models caused:

1) projects must wait at each gate until all tasks have been completed;
2) overlapping of stages is all but impossible;
3) projects must go through all gates and stages;
4) no provision for focus i.e., no attention to resource allocation/project prioritisation;
5) some New Product processes are spelled out in far too much detail;
6) some New Product Processes tend to be bureaucratic;
Cooper (1994) then goes on to suggest that updated processes are already evolving from today's stage gate systems, with particular emphasis on speeding up the process and more efficient allocation of developmental resources. He suggests that these processes represent a precarious balance between the need for thoroughness of action and complete information versus the need for speed.

Cooper suggests that these processes have 4 fundamental Fs:

**Fluidity**, overlapping and fluid stages for greater speed by reducing long lead time activities. Although he cautions that it should not apply to all activities or all the time and that deviations from the norm should be made consciously at the gates and with full recognition of the risks involved.

**Fuzzy gates**, featuring conditional ‘Go’ decisions, which are dependent on the situation, i.e. they should only apply to some projects and to some of the tasks/information.

**Focused**, so that the process builds in prioritisation methods that look at the entire portfolio of projects and focus resources on the "best bets" to improve resource allocation. One solution he suggests is to introduce a New Product Information and Tracking System into the gate meetings to track the progress of all projects, however, one problem with these is that forecasts of resource requirements can be unreliable. A second, complementary solution suggested is the use of portfolio models which enable managers to see at a glance the nature, composition, and expected impact of projects already in the pipeline. One example is provided by Wheelwright & Sasser (1989), ‘The New Product Development Map’. This maps out all past projects to show how present resources are allocated and by using submaps identifies, for example, critical skills and distribution figures. It can also highlight market trends. They suggested that it is also a way to facilitate co-operation throughout the new product development process.

**Flexible** - it is not a rigid stage-and-gate system: each project is unique and has its own routing through the process, i.e. not all gates need to be passed through; nor are all the stages essential. Cooper suggests that the Project leader and the team decide how the
model is used to meet the specific needs of the project while adhering to its proven principles.

Cooper also suggests a 5th F: **Fallibility/Failure**, which is a possible negative consequence. The process introduces much more freedom and discretion to project leaders, teams and senior managers which increases the odds of failure. He states that, "the process is more delicate, sophisticated, and sensitive, thus requiring a more experienced, professional management approach", and also notes that there will be some shift in decision-making authority to the team.

Takeuchi & Nonaka (in Dolan, 1991) identify that leading companies show six characteristics in managing their new product development process:

1) Built-in instability - broad goals on general strategic direction
2) Self-organised project teams - creating their own dynamic order
3) Overlapping development phases
4) "Multi-learning" - across multiple levels and functions
5) Subtle Control - to prevent ambiguity and tension from turning into chaos
6) Organisational transfer of learning - from the project members to others outside the group

These six characteristics together create a fast, flexible holistic process for new product development. They also, however, identify some limitations, and suggest that the holistic approach may not work in all situations, because:

- It requires extraordinary effort on the part of all project members
- It may not apply to breakthrough projects that require a revolutionary innovation
- It may not apply to mammoth projects where face-to-face discussion would hamper the project
- It may not apply to an organisation where product development is masterminded by a genius who makes an invention and then passes it on with a well-defined set of specifications.
Therefore, there is now a consensus that the NPD process should be done in a holistic approach through constant interaction of a closely integrated, multi-disciplinary team of experts (Crawford, 1997; Douglas et al., 1983; Takeuchi & Nonaka, 1986; Wind and Mahajan, 1997).

Taken to an extreme, however, would this new style process ultimately lead to no system at all? Cooper (1994:14) denies this, stating that "there is a big difference between a system with flexibility, adaptability, conditionally, and fluidity and no system at all. No system at all is chaos - it is like driving an automobile in new territory with no roadmap; but a system that is fluid, adaptable, conditional, situational and flexible provides the roadmap, where detours and deviations are possible, and where they are clearly marked and consciously decided upon."

However, these established processes do not seem to have been well accepted by practitioners and failure rates are still high. This under-utilisation may be the manifestation of what has been noted by scholars, that models: (1) fail to account for internal and external efforts; (2) lack interdisciplinary perspective; (3) are inflexible; (4) fail to reduce development time; (5) perform poorly under dynamic market conditions; (6) lack sufficient accuracy (Wind and Mahajan, 1988); (7) have suspect construct validity and temporal stability (Montoya-Weiss and Calantone, 1994) and (8) suffer from survivor bias (Kerin, Varadarajan and Peterson 1992; Mitchell, 1991).

Cooper (1983) suggests that the concept of an average NPD process is misleading. In fact, as Craig and Hart (1992) identify each process has its own distinct set of activities and emphases, is not sequential and has activities which overlap or are undertaken in parallel.
2.2 ORGANISING FOR NEW PRODUCT DEVELOPMENT

Organising for new product development is a complex problem due to the complexity of the process itself. The continual changes in the environment surrounding the new product development organisation will force change in the organisation itself (Wind and Majahan, 1997.)

Many researchers have found it helpful to use models to analyse the various factors. Numerous models are available with which to analyse organisations, such as the one proposed by Handy (1985), and the McKinsey 7S model (popularised by Peters and Waterman, 1982). Johne and Snelson (1987) suggest that this model is also applicable at the task group or business unit level, and hence their application of it to analyse new product development organisation.

The relative effectiveness of different project management structures for product development was assessed in a large empirical study by Larson and Gobeli (1989). The researchers identified five types of structure on a continuum from single-function segments to the multifunctional project team:

1) Functional: The project is divided into segments, which are assigned to relevant functional areas or groups. The project is co-ordinated by functional and upper levels of management.

2) Functional Matrix: A project manager with limited authority is designated to co-ordinate the project across different functional areas. The functional managers retain responsibility and authority for their specific segments of the project.

3) Balanced Matrix: A project manager is assigned to oversee the project and shares the responsibility and authority for completing the project with the functional managers: there is joint approval and direction.

4) Project Matrix: A project manager is assigned to oversee the project and has primary responsibility and authority for the project. Functional managers assign personnel as needed and provide technical expertise.

5) Project Team: A project manager is put in charge of a project team composed of a core group of personnel from several functional areas. The functional managers
have no formal involvement. Project teams are also referred to as tiger teams or venture teams.

The results of the study indicate that there is no one best way to organise a new product project, but that some are better than others (Larson and Gobeli, 1989). The three multifunctional team approaches (3, 4, and 5) yield the best performance and all have roughly the same high success rates. By contrast, the two functional approaches (1 and 2) produce significantly poorer results. Projects using either of these two management structures lag behind the others in terms of schedule, cost, and technical performance.

This is backed up by Cooper (1993:99) who suggests that, “the multifunctional nature of innovation coupled with the desire for parallel processing means that a team approach is mandatory in order to win at the new product game”.

Gruenwald (1985) suggests that the most appropriate project management structure is dependent upon many factors including: the nature of the organisation and its goals; the corporation's management style; the calibre, motivations, and growth potential of the staff in place, the orientation of the corporation; and even its geography. Craig and Hart (1992:38) suggest in their recommendations for the future of NPD research "that it may be better to adopt a contingency approach to researching the dynamics of NPD." A contingency approach "emphasises the importance of situational influences on the management of organisations and questions the existence of a single best way to manage or organise". Contingency approaches to theory building represent an alternative to searching for universal principles, and instead focus on key situational relationships.

2.2.1 COMPANY CHARACTERISTICS

Souder (1987) classifies four generic types of structure, and suggests that each has its own advantages and disadvantages. He found that the type of structure varied depending on whether the company was proactive or reactive. It was also found to depend on the level of innovation required.
Bentley (1990) summarises the findings of previous research studies into the company characteristics most associated with new product success.

Bentley then carried out an empirical study of the hypothesis that, "the structure and style which a company adopts is closely related to its ability to connect with its market, and hence its ability to gather good market information vital to produce new product successes". Bentley suggests a flexible structure and style which supports the ability of individuals to behave innovatively.

Millson (1993) in his study of 'the association of organisational integration with NPD proficiency and success' found that overall organisational integration and internal integration - defined as the integration between a new product development team and a firm's functional departments were found to be significantly correlated with new product success. This suggests that companies must not isolate their NPD function but rather, consciously consider how they integrate it with the rest of the organisation.

Rothwell and Whiston (1990) also advocate a flexible, organic style of organisation which is characterised by:

1) freedom from rigid rules;
2) participative and informal;
3) many views aired and considered;
4) face-to-face communication;
5) interdisciplinary teams, breaking down department barriers;
6) outward looking;
7) flexibility with respect to changing needs, threats and opportunities;
8) non-hierarchical;
9) information flows downwards as well as upwards.

However, with respect to these findings, the results from the study carried out by Rubenstein et al. (1976) showed that, for their study, organisational structures in isolation do not make R&D projects successful. The formal aspects, such as structure, the control mechanisms and formal decision-making processes, were shown to have little effect.
2.2.2 NPD STRATEGY

Many authors have strongly supported the idea that new product development should be driven by corporate strategy (Crawford, 1997; Twiss, 1986; Saren, 1984). Booz et al. (1982) revised their earlier interpretation of the new product process to include strategy, and that this new product development strategy should be driven by the corporate strategy and objectives. New product strategy links the new product process to the company’s objectives, and should provide guidelines for decision making throughout the development process. Thus, the new product strategy will define the strategic role new products will play in fulfilling corporate objectives. A Booz, Allen & Hamilton (1982) survey identified that respondents, when asked what strategic role their most successful recent new entry served, mentioned 8 different strategic objectives, which, they suggest, can be divided into those which were externally driven and those which were internally driven, as highlighted by figure 2.3. They argue that success favours those that implement company specific approaches, driven by corporate objectives and strategies.

Cooper and Kleinshmidt (1987b) also identify that new product strategy and execution results from the new product process activities in an environment of resources, experience and skills in marketing, production and technology.

Traditional strategic approaches such as PIMS (Buzzell and Gale, 1987) usually deal with existing products and are of little help in NPD work. However, strategic typologies are linked to performance (Cooper, 1984, 1985) with new product outcomes determined, not from initial strategy alone, but from the interaction of the market environment with the new product strategy (Cooper and Kleinschmidt, 1987b). The NPD process is also linked to company objectives, which, in turn, loop back to provide guidelines for the next project’s screening criteria (Booz et al., 1982).
The choice of a particular type of new product strategy will vary from company to company and often depends upon the circumstances. Some companies will even use different strategies for different products depending on their specific objectives for each product.

After a study of product innovation strategies, Cooper (1985) concluded that new product performance and strategy are closely linked. Cooper classified five alternative strategy scenarios:

1) Technology driven strategy; involving high technology, innovative, state of the art developments. These strategies are technology driven with a non-market orientation.
2) Balanced strategy; where new products are technologically sophisticated and innovative, combined with a strong degree of product fit, focus and market orientation.

3) The technologically deficient strategy; where new products are low technology, "me too", low risk efforts relying on mature technologies.

4) The low budget conservative strategy; with low R&D spending and a "stay close to home approach".

5) The high budget diverse strategy; a high R&D budget with an unfocused and diverse approach to new product development.

He then analysed these in terms of their performance and effect on the chances of new product success, and found that the balanced strategy gave by far the strongest performance.

### 2.2.3 MANAGEMENT

At a strategic level many studies have shown that top management support is a critical factor in successful new product development (Rothwell, 1977; Booz et al., 1982; Maidique and Zirger, 1984). However, Cooper and Kleinschmidt (1987a) found less proof of top management influence. Their study suggested that new product failures had as much top management support as successes.

In considering how best to get top management involved, Ramanjam and Mensch (1985) found that by approaching innovations as strategic choices, top and middle management become directly involved in setting goals and allocating resources. However, Maidique and Zirger (1985) also found that over involvement by senior management can cause delays and upset the innovation process.

Top management also have responsibility for the overall organisational structure, managing how people and functions relate to each other and where the authority for particular decisions lies (McDonough, 1986).

Project managers have an even more significant role to play in new product development. This role is partly determined by the overall structure of the organisation, and partly from
the project structure, as project managers will have lesser, or greater degrees of authority and control depending on the type of project structure and overall organisation structure that is in evidence (Larson & Gobeli, 1989). The recurring theme on the issue of management style is that project managers should delegate responsibility to the project "team", and McDonough & Leifer (1986) highlight that some degree of autonomy and a sense of ownership is also important. Another important element of this style of management is that the managers must set clear boundaries within which the project team can work, which requires well defined project objectives.

Craig and Hart (1992) identify three areas on the ‘people’ aspect of NPD, the: functional co-ordination; the importance of information and the way in which it is communicated; and the skills required for developing products successfully.

Pinto & Pinto (1990), found that the higher the level of cross-functional co-operation, the more successful the outcome of the firms new product development. They define cross-functional communication as, "the vehicle through which personnel from multiple functional areas share information that is so crucial to the successful implementation of projects" (1990:201). They also note that, as with R&D and marketing communications the most important mode of communication is informal.
2.3 SUCCESS AND FAILURE LITERATURE

Responding to both the opportunities and the risks associated with new product development entails companies and their managers gaining a better understanding of the factors which cause success and failure. Over the past 30 years the importance, yet elusiveness, of successful new product development has lead to a large number of research studies, from a variety of different domains, being carried out to identify the factors associated with successful NPD. The aim of these studies has been to provide theories to organisations on the best practice of NPD, from theoretically prescriptions to empirical contributions.

Early research into the factors associated with the success and failure of new product developments consisted mainly of case studies (Carter & Williams 1957, Myres & Marquis 1969). Utterback (1974) reviewed many of the early case studies and commented that they were of a distinctly descriptive and non-cumulative nature. He concluded that the case study method offered a source of ideas and hypotheses for further research, but did not give the means for a deep understanding of the innovation process. The results from the research have mainly been presented as lists of factors or conclusions on new product success.

With any attempt to improve the process of innovation it is important that managers are aware of the factors associated with success or failure. These critical success factors (c.s.f.) are, according to Bullen and Rockart (1981), a few areas in which satisfactory results will ensure successful competitive performance for the individual, department or organisation. C.s.f. can be characterised by the extent to which they are internal or external to the company and, consequently, whether they refer to something which should be monitored or actioned.

This section reviews the key research into new product success and failure, identifying key progressions in research knowledge. Both failure and success patterns have been studied, typically on the assumption that they were models to avoid or emulate. First, the most important research studies that have looked at what factors are associated with
failure and/or success will be summarised. These studies have made a substantial contribution to research in this area, however the main weakness of these unilateral studies is that they do not compare success with failure. Therefore, studies relating to the comparison of success and failure are discussed next. Finally the important contributions to research are summarised.

2.3.1 REASONS FOR FAILURE

Three major studies have been carried out by the Conference Board (Cochran & Thompson, 1964; Hopkins & Bailey, 1971; and Hopkins, 1981) which focus specifically on new product innovation and development and entail the most comprehensive analysis of new product failures.

The first study, Cochran and Thompson (1964), analysed a sample of 87 U.S. companies that had each introduced a major new product within the previous five years, concentrating on the causes of failure. The study identified eight reasons for the failure of new products, with over a half of the companies surveyed mentioning that the first three had a strong contribution:

1) Inadequate market analysis
2) Product defects
3) Higher costs than anticipated
4) Poor timing
5) Competition
6) Lack of effective marketing effort
7) Inadequate sales force
8) Weakness in distribution

The study also addressed the positive steps companies had taken to improve their new product programmes to increase their chances of success. The major remedies identified included: better screening and research for new product ventures, improving procedures and communications and ensuring better control and quality throughout the process.
Almost a decade later an identical study was carried out by Hopkins and Bailey (1971). The results of this study (see figure 2.4) were almost identical to those of the first study.

**Figure 2.4- Causes of New Product Failure**

![Graph showing causes of new product failure]


The most recent Conference Board study, Hopkins (1981) involved 91 medium to large sized firms, again from the U.S., and yet again the results were very similar. The most common causes of failure being: poor marketing research; technical problems in design or production and bad timing. The recommendations once again called for market research to be improved.

The Conference Board studies are quite unique in the fact that they have repeated an almost identical study over a period of time, and despite the sixteen year interval between these studies the results are strikingly similar, although the importance of some of the causes of failure have changed. For example, technical or production problems where not even identified in the 1964 study, they were the seventh principal cause in 1971 and in 1981 they appeared second on the list. These changes in importance could be
highlighting trends that need to be identified in order to target improvement effort at the right problems.

Similarly Cooper's (1975) investigation of new product failures found a low level of sales was the most important general reason for failure. The specific causes of low sales levels included: firmly entrenched competitors; overestimating the number of potential users; high price; technical difficulties with the product and misdirected marketing efforts.

A convenient categorisation scheme for new product failures was presented by Calantone and Cooper (1979) who identified six scenarios: 1) the better mousetrap that nobody wanted; 2) the "me-too" product meets a competitive brick wall; 3) competitive one-upmanship; 4) the technical dog; 5) price crunch; and 6) plain and simple ignorance.

One recurring theme of these studies of failure is that the overwhelming causes of failure were marketing, not technical problems. These were exemplified by inadequate market analysis, product deficiencies, higher costs than anticipated, poor timing, competition, insufficient market effort, inadequate sales force and weakness in distribution.

2.3.2 KEYS TO NEW PRODUCT SUCCESS

The motivation behind these investigations was to infer future patterns of success from past patterns of success (e.g. Cooper, 1976; Globe et al., 1973; Marquis, 1969; Myers and Marquis, 1969; Roberts and Burke, 1974). One of the earliest investigations of success factors in new product development by Myers and Marquis (1969) looked at 567 successful product innovations, and concluded that most were market-pull projects, only 21% were technology-push. They were also among the first to recognise that a new product process exists: that some firms had in place a plan or process consisting of a logical flow of activities, from idea to launch. A simple five-step model was proposed as a result of studying these 567 successes and suggested that optimising technology-push and market-pull factors was important.

Globe, Levy and Schwartz (1973) are typical, finding early recognition of need and adequate funding important to the successful innovation process. External factors such as
economic, political and social factors were least important, with formal market analysis far down the list.

Cooper (1976) looked at the success process for three model products at Dupont, Northern Electric and Pratt and Whitney. He linked success to a stage-wise process of sequential, multi-disciplinary, multi-functional yet integrated activities supported by technical and market research. Each GO stage meant to ‘go only to the next stage’ with constant re-evaluation, providing timely bailouts. This laid the groundwork for the more recent stage-gate process studies (Cooper, 1994; Cooper and Kleinschmidt, 1991).

2.3.3 SUCCESS VERSUS FAILURE

There is much to learn from both of these methods, however, the fundamental flaw is that they only look at one side. A common factor identified as important to successes may also be shared by failures. Therefore, in order to uncover the keys to success, the researcher must identify factors that separate winners from losers (Cooper and Kleinschmidt, 1993b) hence, the need for both types of projects to be compared within a single study.

The premise underlying these works was that only through a direct comparison of successes and failures could the variables that discriminate between them be identified. Works that attempt to discriminate using simple discrimination and dimensional comparisons (not forecasting models) include Gerstenfeld (1976), Maidique and Zirger (1984), Rothwell (1972), Rothwell et al (1974), and Rubenstien et al (1976). Particularly representative of these studies was Project SAPPHO (Rothwell 1972; Rothwell at al, 1974).

In the early 1970's researchers at the Science Policy Research Unit (SPRU) carried out Project SAPPHO (Rothwell, 1972, Rothwell at al, 1974) in the UK and Europe. This was the first empirical study to systematically compare successful and unsuccessful innovations from the same market. Project SAPPHO was a comparative analysis of "paired" commercially successful and unsuccessful technological innovations. Phase I (1972) involved 29 pairs, and this grew to a total of 43 success/failure pairs during Phase
II (1974), 22 from the chemical process industries and 21 from scientific instrument industries. The Phase I results were confirmed when the same five underlying factors were identified in Phase II.

They identified that successful innovators:

1) Had a much better understanding of user needs;
2) Paid more attention to marketing and publicity;
3) Performed their development work more efficiently than failures but not necessarily more quickly;
4) Made more use of outside technology and scientific advice, not necessarily in general, but in the specific area concerned;
5) Had responsible individuals for successful attempts in more senior positions with greater authority than their counterparts.

The results from the SAPPHO studies showed that NPD is very dependent on key people, suggesting that good management techniques and performance can enhance results, but, that there is no substitute for good quality managers who have flair and ability.

The results also showed that there is no simple formula or panacea for success. Successful new product developers outperformed in all aspects identified, suggesting that success depends on doing most things well, in a balanced and co-ordinated manner. They concluded that, to successfully innovate requires a matching of a company's technological capacity to the needs of the marketplace.

In 1976 Rubenstein et al. carried out a study of research and development projects in the U.S. to identify the barriers and facilitators in the innovation process. The sample was made up of a total of six different firms that were involved in the manufacture of household consumer products, engineering products, industrial products, chemicals, naval machinery and defence related products. The study analysed a total of 103 different projects, measuring them using the following variables:

1) The nature of the firm
2) The impetus for innovation
3) Project decision process and criteria
4) Project structure and process
5) Organisation structure and process
6) The outcome of the project in terms of its technical progress, commercial success and overall success.

Through a detailed analysis of the findings Rubenstein et al. were able to identify a number of issues. The results showed that organisational structures do not make R&D projects successful. The formal aspects, such as the structure, the control mechanisms and formal decision-making processes were shown to have little effect. Many of the projects showed that individuals had played key roles in the initiation, progress and outcome of a project. They also found that the factors associated with both technical and commercial success fall into three groups: the establishment of a defined market with a well specified need; communication patterns and information flows within the organisation; and the interest and support of top management. However, they identified that there was no one factor governing success.

In their conclusions Rubenstein et al (1976) made various policy recommendations to overcome some of the obstacles identified, suggesting that there were two areas where organisation redesign and policy effort should be concentrated: to improve communication in terms of frequency, openness and timing; and to make major improvements in methods of data gathering, analysis and decision making.

This study clearly demonstrates the importance of people to the new product development process.

Project NewProd is a series of research studies that have looked into firms new product practices, focusing particularly on what separates winners from losers. Begun in the 70s, the NewProd database includes over 1000 case studies from both North America and Europe. This work was paramount in the maturation of the field focus and method.
In 1979 Cooper carried out Project NewProd I, a large and comprehensive study into what separates successful from unsuccessful industrial new products (1979a, 1979b).

Initially, Cooper carried out a review of past research to identify many of the variables that had been found to influence the outcome of new products. Using these variables a conceptual model was developed that identified the main group of factors that influence new product outcomes. These groups of factors were:

1. The commercial entity
2. The information acquired
3. Proficiency of process activities
4. Nature of the market place
5. Resource base of the firm
6. Nature of the project

These provided the conceptual framework (1979a) for Cooper's success/failure initial screening forecasting models (Cooper 1979b, 1981).

From these six groups, a list of 77 variables that were thought to influence the outcomes of new products was developed. A random sample of 177 firms were selected from a list of active industrial product producers. "Functionally neutral" respondents, who had an overall knowledge of the firm's total new product development efforts, were then identified by phone and mailed a questionnaire. They were requested to select two typical new products, one that had been a commercial success, and the other a failure, both from the viewpoint of the firm.

By correlating the results Cooper identified that the 77 variables could be explained by 18 underlying dimensions or factors. Of these, 11 were found to differentiate between successful and unsuccessful new products. These were presented in terms of three keys to success, three barriers, three facilitators, and two that were only weakly related to success. Cooper also noted that projects that were high on all three of the dimensions had a 90% chance of success and conversely 93% of projects that were low on all three dimensions failed.
Keys to Success:

1) Introducing a unique and superior product
2) Having market knowledge and marketing efficiency
3) Having technical and production synergy and proficiency

The three barriers were:

1) Having a high priced product relative to the competition with no economic advantage to the customer
2) Being in a dynamic market where new products are introduced regularly
3) Entering a highly competitive market were customers are already well satisfied with competitors offerings

The three facilitators were:

1) Having a good "product/company fit", or synergy with respect to managerial and marketing resources
2) Having strong marketing communications and a strong launch effort
3) Being in a large, growing, high need market

The other two weakly related factors were: avoiding products new to the firm; and having a market derived idea with considerable investment involved.

The Project NewProd I results were presented in much more detail than other studies, although the study did differ in terms of its orientation towards product and market characteristics, with very few management, communication or people oriented factors.

The second investigation carried out by Cooper and Kleinschmidt (1987a,b,c) - NewProd II - takes a much broader perspective of new product success. The two questions addressed were: 1) How can new product success be measured, and are there independent dimensions or different ways of looking at success? 2) What are the components of success when success is viewed in different ways - are the components the same regardless of the way we measure success?

The study investigated over 200 new product case histories in 125 industrial product firms. All products had been launched, 123 were successful and 80 were unsuccessful.
For each product information was obtained for five key areas:

1) The nature of the product itself, including the product's differential advantage
2) The nature of the product's market - how attractive the market was
3) The nature of the purchase, in particular whether or not it was a high-risk purchase for the customer
4) The synergy or "goodness of fit" between the new product project and the firm's resources, skills, and experience
5) The "determinateness" of the project - how well defined the project or "protocol" was prior to product development

New product success was gauged in each of ten different ways, listed below.

1) Profitability level
2) The product's pay back period
3) Domestic market share
4) Foreign market share
5) Relative sales
6) Relative profits
7) Sales vs. objectives
8) Profits vs. objectives
9) Window on new categories
10) Window on new markets

The 203 products were compared on the 10 performance gauges using factor analysis. This identified three independent and strong dimensions that characterised new product performance. These were: Financial Performance; Opportunity Window, which portrays the degree to which the product opened up new opportunities to the firm; and Market Impact.

The authors believe that these performance dimensions helped to clarify what is meant by new product success, and comment that "success is not a simple, one-dimensional concept, as has been assumed in previous studies. Nor are the many possible measure of
success independent of each other”. The implication of their findings is that what leads to one type of success may not necessarily lead to another type, which they then tested using simple correlations.

They also highlight some factors that did not impact on success, such as: low priced products, which were no more or less successful than other products; synergy with financial resources, which was uncorrelated, suggesting that money was not the deciding factor, other synergies were found to be more critical; and new products aimed at large markets were no more successful than those aimed at smaller markets.

They conclude by providing six specific lessons for the management of new industrial products extracted from the investigation:

1) New product success is a multidimensional concept
2) There is a consistent and logical pattern to new product success and the components of success for one type of performance were different than for other types of performance - the type of success desired will affect the success factors
3) Product advantage is a dominant factor in success
4) A well defined project prior to the development stage is critical to success
5) Synergy is vital when it comes to achieving financial performance from a new product
6) The market environment itself appears to have relatively little impact on new product outcomes.

Following these two landmark studies, Cooper and de Brentani (1984) studied managerial accept/reject criteria. Generally consistent with NewProd, new factors perceived important to managers at the initial screen included financial potential, product life, domestic focus and types of strategy (market maintenance and diversification strategy). Comparison to Cooper’s earlier work suggests that differences exist between perceived causes of success/failure and criteria perceived important to the managers’ accept / reject decision. This is the first indication that a “reality check” (Calantone et al., 1995) problem might exist in the forecasting branch of the literature.
Kleinschmidt and Cooper (1991) have also carried out research on innovativeness and its impact on success rates considering three classes of new products:

- Highly innovative
- Moderately innovative
- Low innovativeness

Their findings suggested that the relationship between product innovativeness and new product success was not as straightforward as expected and recanted previous findings on innovation because of the inappropriateness of linear research methods. The relationship was found to be U-shaped between product innovativeness and two key measures of performance - success rate and Return on Investment (ROI). In other words, innovative products do well; so do non-innovative ones. They also state that the curved pattern observed is clearly true across the board, and not just for one or a few measures of performance.

The chemical industry in four countries provided the setting for Coopers’ (1993) most recent NewProd investigation. This study uncovered many of the same success factors as the previous studies, but there were also some new insights:

- Source of idea: Supplier-derived new product ideas, although representing only a handful of projects, had the highest success rate (86%). Next were customer derived ideas (77%). The worst source of ideas was competitors (59% successful).
- Order of entry: The strategies of "first in" versus "be a follower" are just about equal. Products that were first into the market had a marginally higher success rate (71%). Success rates dropped off with later orders of entry, down to 57% for third into the market or later.
- Product life cycle: The stage of the product life cycle (PLC) of the new product's market has some impact on performance. Products aimed at markets or product categories in the introductory PLC stage yielded high failure rates, 58%. By contrast, new products in early growth phase categories fare well (81% successful),
with a gradual falling off of success rates with successive stages (down to 58% successful for new products aimed at mature markets or categories).

- **Differential advantage.** As in virtually every new product study, competitive or differential advantage proved critical to success. By contrast, nonproduct elements of differential advantage had relatively little impact on new product financial performance, except customer service.

- **Benefits delivered.** The exact nature of the benefits delivered did not decide success or failure.

- **Organisation.** Projects undertaken by multifunctional teams were far more successful than no teams or single-department teams.

Kleinschmidt and Cooper (1995) have also carried out a study to investigate the key success determinants and probe 'whether they are consistent with managers' perceptions', i.e. they were interested in the gaps between 'reality and perception'. This study was prompted by the fact that, while numerous studies had researched into the keys to new product success, the failure rate was still high, and they suggested that this could be due to the fact that these new insights were not being heeded by managers.

Data was gathered on 103 major new product projects (successes and failures) from the Chemical Industry which had been launched over the last 5 years. The single industry was chosen in order to minimise inter-industry, inter-market effects that, the authors suggest, “have tended to detract from most previous success/failure studies” (1995:285).

The authors first developed a conceptual framework which identified the blocks of variables that might impact on new product performance deduced from the literature and previous studies (Figure 2.5). The data was then collected on these variables using a detailed 16 page, pre-tested questionnaire.
The findings identified that there were serious and potentially damaging gaps between managers' beliefs and reality for many of the important success elements: Quality of execution of the activities in the new product process is one of the most critical block of success elements, yet the authors found that the gaps were greatest for these variables; Marketing and business tasks seem to suffer at the expense of technical activities; Project familiarity is a confused concept, which managers over-emphasise. However, one positive aspect of the study was that managers were surprisingly astute regarding certain success determinants such as, product advantage, product definition, project organisation, and elements of synergy.
The authors conclude that by bringing about closer alignment between actual success factors and what managers believe to be important, the hope is that both project management and project selection will improve.

The Stanford Innovation Project (SINPRO) began in 1982 as a long term study of U.S. industrial new product development, focusing on the electronics industry. This sector was chosen because of the rapid technical change it was experiencing. Maidique and Zirger (1984) believed that high technology industries, like the electronics industry, provide a fertile ground for the study of new product success.

The methodology chosen for the research attempted to address some of the gaps that had been left by previous research. The research sample was based on 120 participants of the Stanford AEA Executive Institute, who were mainly presidents, vice presidents or functional managers of electronics firms. The study was divided into three parts, each with a specific purpose, conducted in sequence so that progressive refinements could be made to the hypotheses.

The authors thought the literature variable pool was lacking. Therefore, part 1 was used to identify the variables associated with the success and failure of new products. This involved the respondent answering a series of open-ended questions about one success and one failure that they had selected. The second stage involved a detailed questionnaire, similar to that of the SAPPHO study. The final stage involved in-depth case studies in 20 of the companies that had participated in both parts one and two.

The results presented by Maidique and Zirger (1984) were in the form of a list of eight factors associated with new product success, which were:

1) **Market knowledge gained through frequent and intense customer interaction, which leads to high benefit to cost products.**
2) **Planning of the new product process especially the R&D phase.**
3) **Co-ordination of the new product process, especially the R&D phase.**
4) **Emphasis on marketing and sales.**

45
5) Management support for the product throughout the development and launch phases.
6) The contribution margin of the product.
7) Early market entry.
8) Proximity of the new product technologies and markets to the existing strengths of the developing unit.

Again the study emphasised the need for management support, good market knowledge and the need for a well planned new product process which is consistent with the findings of Rothwell (1972), Rothwell et al, (1974) and Rubenstein et al, (1976).

However, no forecasting model was developed until the follow-up six years later (Zirger and Maidique 1990). Using discriminant analysis for dimension determination and forecasting, the high-tech biased, deterministic model found excellence of the R&D organisation, to be the most important dimension of success. Superior technical performance and product value were next. Like the NewProd study, a weak competitive environment was also important to success.

The Stanford project combined statistical analysis with in-depth clinical surveys and the interaction between these two apparently helped the researchers gain richer insights on certain key concepts (eg. "market understanding") and capture dynamic aspects of the innovation process (eg. learning cycles), which might have been difficult by statistical analysis alone.

2.4 KEY ISSUES

As well as the specific literature detailed above, there is also a body of research providing reviews of these and other past research studies. These have sought to synthesise their findings, as well as to highlight the differences between these studies in order to reduce the complexity of the available literature. They also provide recommendations as to what future research is required to move the knowledge about the discipline forward.

Craig and Hart (1992) carried out a detailed review of the different research approaches taken and identified a number of issues differentiating studies. These have been used to
identify the key issues affecting the literature, which will be discussed below, including other literature where appropriate.

2.4.1 THE SCOPE OF THE STUDY ("GENERALIST" VS "SPECIALIST")

The "generalist" studies seek to identify sets of variables with respect to their impact on new product projects and programmes, and include a number of major studies, as highlighted in section 2.2. The "specialist" studies identify one or two particular areas of NPD from the "generalist" literature and concentrate on an in-depth investigation, for example, Kleinschmidt and Cooper (1991) and Hart and Service (1988).

2.4.2 METHODOLOGICAL APPROACH

A substantial amount of NPD literature is theoretically prescriptive rather than empirically based, with the aim to clarify some of the most puzzling areas of NPD, such as the article by Wind and Mahajan (1981) in which the importance of creating a conducive market environment is proposed.

The empirical articles have used both qualitative and quantitative methods. The qualitative studies have generally used case study (e.g. Bentley, 1990; Maidique & Zirger, 1984) and in-depth interview techniques, whereas the quantitative surveys that are most cited are those with large samples using statistical analysis (e.g Cooper, 1979a). There are also a few studies which use a combination of quantitative and qualitative, for example Maidique and Zirger (1984).

Another methodological issue is the population study differences. Some focus on a variety of industries (Hopkins, 1981), whereas others concentrate on just one to find out if the general findings on critical success factors holds true for a particular industry (Maidique & Zirger, 1984; Nystrom, 1985).

These differences make it very difficult to compare and contrast studies. Maidique and Zirger (1984:195) emphasise just how important, saying "exactly which set of factors predominates seems to be, at least in part, a function of both the methodology and the specific population studied by the researcher". However, if knowledge in this discipline
is to be advanced, this issue needs to be addressed in order to provide some consensus on the most appropriate methods for different aspects of enquiry (Craig and Hart, 1992).

2.4.3 LEVEL OF ANALYSIS

The studies also differ in terms of the level of analysis at which the studies are focused. Some focus on the outcomes of individual new product projects and seek what is critical to the specific outcome (Cooper, 1979a, 1979b, 1980; Maidique & Zirger, 1984; Nystrom, 1985). Others, however, try to identify the distinguishing features of successfully innovative organisations, such as Hart & Service (1988) and Rothwell et al. (1974). The information for individual projects is often more readily identifiable and available, however, one reason for studying at the organisation level is that one project is not a sufficient measure of a firm's ability to innovate, and that a longer term perspective is needed.

2.4.4 SUCCESS, FAILURE OR BOTH?

The earlier studies tended to concentrate on the causes of failure in order to identify pitfalls. Others focused on identifying the critical success factors for successful product developments as a guide to 'best practice'. However, Craig and Hart (1992) argue that both these methods ignore the possibility that the critical factors unearthed by the investigations could also be determinants of the opposite outcome. Project SAPPHO (Rothwell, 1972; Rothwell et al., 1974) was the first investigation to compare success with failure, and this method has now become the accepted norm for other later studies.

2.4.5 TYPES OF PRODUCT DEVELOPMENT

Different types/degrees of product development, from product modifications to radically innovative/breakthrough products, have been studied. However, these findings are scattered and inconclusive and it is not always clear from the literature which type the research studies are aiming at, with only 31.9% of the research reporting the type of innovation studied (Montoya-Weiss and Calantone, 1994; Craig and Hart, 1992). Myers and Marquis (1969) showed the great majority of 567 successful incremental innovations
were market derived and only 21% were technology push, however, they did not produce any forecasting model. NewProd considered innovativeness a moderating variable only (Cooper, 1979a, 1979b, 1980) emphasising that innovative products are not all that different from “me too” products. Maidique and Zirger (1984, 1990), did not find product innovativeness to be a success factor at all.

However, these findings need re-examination in light of the fact that all previous linear NPD work failed to identify the curvilinear phenomenon inherent in innovativeness (Kleinschmidt and Cooper, 1991); and that Cooper recently found highly innovative products achieved an admirable track record (Cooper, 1994).

2.4.6 MEASURING SUCCESS

There is very little consensus within the literature over how best to define "Success". In the past financial measures have predominated, however, other "soft"/subjective measures are also applied from time to time, such as, the importance of new products, the degree of innovativeness, and the opening up of new markets.

More recently this issue has been explored in greater depth in a study carried out by Hart (1993). Hart provides an exploratory investigation into the dimensions of success in NPD by examining the performance measures used in several major NPD studies. Then she used data regarding success in new product development from an empirical survey of a cross-section of British manufacturing firms to address the following questions:

1) Can either sales or profit measures be used in cross-sectional mail surveys to give an accurate reflection of financial success?

The results show no significant relationship between sales growth and average profits over a five-year period. Clearly, sales and profit cannot, therefore, be assumed to be "alternative indicators".

2) Can new product development success be measured accurately by using measures of overall financial success?
The results were conflicting with regard to this question, which the authors suggest serves to underline the complexity involved in the measurement of new product success. One suggested explanation was that possibly a higher percentage of successful launches may be the result of heavy investment which affects the average profits.

3) Can indirect measures be used in place of direct measures of success?

The results suggest that asking an indirect, relative question about sales growth yields a picture consistent with a direct measure.

4) What are the main dimensions of success, both financial and non-financial, as defined by business people themselves?

The study identified three measures: a success profile based on using a technological race with competitors; cost reduction and price competitiveness; and ROI by being first to market.

5) To what extent are non-financial success measures associated with financial success measures?

Too few significant associations between these dimensions and the measures of financial performance were found to give any insights into the existence, or lack of, such a relationship.

Hart (1993:36) concluded by stating that, "if research is to throw light on new product success, for the benefit of both the academic and business community, it must clearly show what types of product development strategies and processes will result in what type of success".

Key to understanding the issues related to success and failure of new products is being able to measure ‘success’ and ‘failure’. Past literature identified that there was very little consensus over how best to operationalise “success (Hart, 1993). Traditionally, success was measured on a unidimensional axis and typically in financial terms (Cooper, 1987c, Saunders and Wong, 1985; Baker et al. 1988). However, Maidique and Zirger (1985) recognised the problem of employing a uni-dimensional financial measure of success and
point out, while financial return is one of the most easily quantifiable measures, it is
certainly not the only important one. More recently, other 'non-financial', subjective
measures such as 'innovativeness', customer satisfaction, quality and employee
development have also been used (Nystrom, 1985; Cooper and Kleinschmidt, 1987b,
1987d; Saunders and Wong, 1985).

There has been much debate about the appropriateness of particular measures, and about
the best way to combine these 'financial' and 'non-financial' measures. This use of
different success/failure measures and the "preoccupation with financial results and
financial gauges of success" has made it difficult to draw generalisations across
investigations (Cooper and Kleinschmidt, 1987c: 215).

An important issue that has arisen from this look at how success and failure is defined is
that studies have identified more than one dimension of success. Research undertaken by
a PDMA (Product Development and Management Association) task force identified that
project success consists of three independent dimensions: consumer-based, financial and
technical or process-based success (Griffin and Page (1993), and "since there are
different dimensions of success, then conceivably, there could be three independent sets
of success factors" Cooper and Kleinschmidt (1987c: 217). This report went on to
identify 16 "core" measures of success, both project and programme, which were
common to both practitioners and the literature. After further research, Griffin and Page
(1996) suggest that these measures are the most comprehensive set of post launch
measures. However, the PDMA task force only investigated the subject from the point of
view of practitioners and suggest that other factors and constraints may override the
usefulness of the measures recommended when being used by academic researchers. The
full extent of the possibility of different measures reflecting different success factors has
not been explored by the extant literature (Craig and Hart 1992).
2.4.7 PROCESS SECTION

The more general studies have identified that how well firms undertake the development process, or its' particular activities, is critical to successful NPD (Cooper, 1979b; Cooper and Kleinschmidt, 1987b; Maidique and Zirger, 1984; Rothwell, 1972; Rothwell et al., 1974). More focused research literature, looking at the NPD process, has attempted to study how the proficiency and completeness of these activities affects new product success. For example, Calantone and di Benedetto (1988) undertook a study to demonstrate the nature of the complex interrelationships that exist among the many identified variables, as well as their relative impact upon new product success or failure, as perceived by senior managers of the firms.

The managerially controllable factors chosen included the innovating firm's technical skills and activities, it's marketing skills and activities as well as launch activities. These were included on the basis that a substantial number of previous studies had shown them to be important determinants of new product success or failure.

The model was developed based on the following propositions, concerning the relationships among the variables, developed from the results of previous studies.

1. A firm possessing strong marketing resources and skills will be in a better position to perform adequately marketing activities and market intelligence activities particular to the new product.

2. A firm possessing resources and skills in technical and production aspects of new product development will carry out more adequately the technical activities particular to the new product.

3. Superior performance on market research and intelligence activities allows the firm to perform other marketing and technical activities better.

4. Adequate performance of marketing and market intelligence activities helps the firm in selecting and performing its product launch activities.
5. Adequate performance on technical and marketing intelligence activities has a positive effect upon the quality (relative to competition) of the final launched product.

6. The extent of specific marketing, technical and launch activities and the product quality level influence the ultimate product success or failure.

The model proposed showed an underlying framework linking the variables and how they directly or indirectly affect the new product decision process.

The questionnaire used was an shortened version of Coopers NewProd questionnaire requiring the respondents to rate the development and launch of a new product (launched within the last 5 years) in their company.

To carry out the analysis of this study, the six propositions listed above were directly translated into a system of six equations which were verified empirically by applying three-stage least squares analysis and studying the results.

The study results imply that certain skills are necessary but are not sufficient conditions for success, all the activities highlighted need to be performed adequately for successful product development. Therefore, firms should not rely on being good at one or even some of these activities, but should realise their deficiencies and strive to improve these, while taking advantage of those resources it does possess.

One drawback of the study that the authors highlight is that the model was tested using only data from industrial products and that some effects which possibly may hold for consumer products have not been explicitly tested.

The authors conclude by suggesting that success with new product launches is a function of many variables, including proficient performance of activities, supported by the requisite skill levels on both the technical and marketing sides of a firm (Calantone and di Benedetto, 1988).

This was followed up with a cross-national comparison of these controllable factors of new product success, which was undertaken by Calantone et al. (1996).
The results provide important guidelines for managers concerning the appropriate actions for them to take during the development of new products. The author again identified: 1) the need to build appropriate new product development resources and expertise; 2) that a higher proficiency in marketing and technical activities leads to a higher level of new product success in both countries; and 3) that it is important to collect and assess market and competitive information in order to better understand customers and competitors.

However, the NPD models tend to be very simplistic or idealised and studies into how the development process activities are related to success have tended to use simplified “skeletons” of the process developed from the prescriptive processes. Cooper (1987a) identified thirteen process activities, which were used to determine how important each of the NPD process stages were. However, the findings of these studies have tended to be very general and, therefore, more difficult for practitioners to implement (Craig and Hart, 1992; Montoya-Weiss and Calantone, 1994).

2.4.8 SUMMARY

Craig and Hart (1992) conclude by providing recommendations for future research:

- They noted that it may be better to adopt a contingency approach to researching the dynamics of NPD, which recognises the importance of the situation influences on the management of organisations and questions the existence of a single best way. This is also backed up by Douglas et al. (1983) and Johne and Snelson (1990). They suggest that providing literature of a more contingent nature would allow managers to identify their own situation and adapt the lessons accordingly, rather than having to fit to one specific model which they are unable to relate to.
- They suggest that the research community would benefit from some consensus as to the most appropriate methodology.
- They stress the need for clearer definitions of certain terms, especially success and different types/degrees of product development.
- They also stress the need to focus on understanding the process by which new products can be developed in shorter timescales, with lower costs and less risk.
A third review was carried out by Montoya-Weiss and Calantone (1994), who also attempted to bring synthesis to the field by conducting a comprehensive review of new product performance literature, using meta-analysis techniques to works which: 1) studied a dependent variable measuring the performance of a new product project or programme; and 2) identified one or more explanatory factors as determinants of new product performance.

This review again indicated that there are numerous study design and methodological variations and they suggest that it is highly likely that the persistent exploratory nature of the new empirical research in this area is due to the lack of an organised synthesis of past research, past reviews having generally been selective and consistently qualitative.

Eighteen drivers of performance were found to dominate the literature. These came from the fields of marketing, organisational behaviour, engineering and operations management. The 18 significant dimensions were categorised as follows:

- **Strategic factors** - product advantage, technological synergy, company resources, strategy, and marketing synergy.
- **Development process factors** - proficiency of technical activities, profitability of marketing activities, protocol, top management support/skill, proficiency of pre-development activities, speed to market, financial/business analysis and costs.
- **Marketing environment factors** - market potential, market competitiveness and environment.
- **Organisational factors** - internal/external relations and organisational conditions.

The literature's most studied factors were: 1) Proficiency of technical activities (included in 69.2% of all research analyses); 2) Proficiency of market related activities (61.5%); 3) Product advantage (61.5%); 4) Protocol (46.2%).

The least studied were: 1) the environment; 2) financial/business analysis; 3) costs; 4) strategy; 5) speed to market; 6) company resources.

They do, however, concede that quantitative comparison of results is difficult because of, amongst other things, a wide variation in research design and methods and publication
bias, and that in spite of these substantial variations, researchers are clearly influenced by existing and previous work, thus leading to a series of intercorrelated results.

A study that has given weight to this concern was undertaken by Link (1987), who used open-ended questions to ask respondents to cite any additional variables. Using this method he found three new factors that had not previously been identified. A more recent study by Song and Parry (1996) has identified that there are problems associated with using previously developed variables and assuming they will effectively capture the constructs in a different industry or cultural setting.

The results highlighted some important issues: that no study considered the consistency between responses at different organisational levels; most studies are now dyadic (distinguish between success and failure); that there is an apparent geographic bias; 36.8% of the studies were conducted in Canada; and that information on the type of innovation studied was not well reported.

The conclusions reached and suggestions for future research were very much more specific than those of Craig and Hart (1992), highlighting:

1) the need for broad-based studies that include multiple factors from diverse categories
2) that some factors have not been studied extensively enough to draw strong conclusions regarding their impact on performance
3) the need for more correlation analysis and tests of differences between success/failure groups
4) the need for more studies to compare empirical findings
5) the need to examine the differences between top management perceptions and the various functions' perceptions of the determinants of new product performance
6) the need for consistency and reliability of the measures used within the discipline, (as noted by Craig and Hart, 1992)
2.5 THE AUTOMOBILE INDUSTRY

The Automobile Industry is often used for studies because, as stated by Turnbull (1992), "the car industry is particularly important because it is the single largest industrial sector in the world economy and has traditionally lead the way in establishing patterns of work organisation for other sectors". This is also backed up by Lamming (1993), Womack et al (1990), and Helper(1991), amongst others.

2.5.1 NPD IN THE AUTOMOBILE INDUSTRY

Lamming (1993) states, "the industrial activity in the automobile industry today may be characterised as an application of a mixture of new and old ideas to a mature product in the context of a rapidly changing set of market requirements". In recent decades, in Europe, the limitations of mass production and the striving for economies of scale in fragmented markets have led to a concentration of assemblers and a gradual convergence of designs. In parallel with this development has been the apparent demise of innovation and genuine fundamental product differentiation. He suggests that volume assemblers have reached the point where products are differentiated only by minor technological factors and minimal styling differences. (1993)

Lamming identifies that NPD in automobiles under the mass production paradigm could be seen to suffer from three main limitations:

1. the need for economies of scale in production and product development, leading directly to standardisation and indirectly to limited competition through industry concentration.

2. functional demarcation, a characteristic of mass production, is extended to the new product development process

3. the tendency in the assemblers towards retaining control over all design and technology decisions - a result of high levels of vertical integration.

He goes on to suggest that 'lean production', as described by Womack et al. (1990), which includes the just-in-time concepts pioneered by Ohno, coupled with quality management
techniques developed in Japan by the likes of W.E. Deming and J. Juran, directly counters these limitations.

This ties in with Abernathy et al (1981), who agrees with Lamming about the reduced role of innovation in mass production, suggesting that in the 50's and 60's product technology was competitively neutral. No automobile company sought a competitive advantage through significant innovation. He goes on to state that in the U.S. in the 80's the necessity for advantage through innovation will steadily grow, due to the Japanese entrance into, and subsequent success in, the U.S. market. Abernathy suggests that this has opened up the way for technology to become the relevant basis for competition in the American market, and that these developments mean that, the supposedly mature automobile industry now has the opportunity to embark on a technology-based process of rejuvenation in which the industry could recover the open-ended dynamics of its youth when competitive advantage was based largely on the ability to innovate.

One major research study into product development in the world Auto Industry was carried out by Clark et al. (1987) (see also Clark, 1989 and Fujimoto, 1989), using data on 29 passenger vehicle development projects from 20 auto companies in Japan, Europe and the U.S. (12 from Japan, 11 from Europe, and 6 from the U.S.). The study had two objectives: firstly to characterise and quantify differences among projects in engineering hours and lead time; and secondly to explain these differences in terms of scope and complexity of the project and the way it was organised and managed. They developed three kinds of evidence: quantitative data on the characteristics of the project (its scope and complexity) and its performance through questionnaires and interviews; documentary material on the development process, including internal reports, organisation charts, memoranda, and published articles; and the experience of key participants in the project. Summary data indicated that Japanese projects were completed in two-thirds the time and with one third the engineering hours of the non-Japanese projects. In absolute terms the Japanese used an average of 2 million fewer engineering hours and typically completed a project more than a year and a half earlier, and the figures also implied that the Japanese drew more engineering resources from parts suppliers than did European or U.S. firms.
From the analysis of the data collected the authors conclude that a part of the large Japanese advantage in lead time and engineering hours identified reflects the differences in kinds of vehicles developed and the role of suppliers, but much is real. The best of the Japanese firms seem able to develop a vehicle of competitive quality in much less time and with many fewer engineering resources than their U.S. or European competitors. The authors suggest that this advantage appears to depend on the strength of the Japanese supply base, the Japanese drew more engineering resources from parts suppliers, and the way projects are organised and managed. "In the best of the Japanese projects, a heavyweight project manager leads a multi-functional team, in which problem-solving cycles are overlapped and closely linked through intensive dialogue". This study provides very useful information on positive organisational and management issues from an organisational perspective, however, it does not look at the project activities in terms of which contributed to the success of the project, only how long they took and how many engineering hours were required. It also does not look at the links between the assemblers and suppliers to determine how the advantages identified are created and sustained.

Altshuler et al (1984) indicates that innovation in the automobile industry occurs in one of two ways: through the research and development process of conceiving new concepts, which, he suggests, is often the work of technologists in supplier companies who develop new components and then convince vehicle designers to use them; and through vehicle designers discovering new needs and then developing, or finding a supplier willing to develop, suitable prototypes. These new engineering ideas are then incorporated into automobiles.

Lamming (1993) states that under mass production assemblers limited their own search and selection environments, by largely failing to recognise the value available from independent component manufacturers. The capacity for innovation evident in the component suppliers, coupled with the success gained by lean producers in using the efforts of their suppliers in new product development, suggest that the source of innovation should not be restricted. He suggests that some new model of development is
required which exploits the innovation resident in component suppliers and allows it to
grow. The implications for component suppliers are that the recognition of technical
abilities, including the ability to innovate, should presage a new era of development
within the automobile industry.

2.5.2 THE NEED FOR NPD IN THE AUTOMOBILE INDUSTRY

One of the most important demands on the automobile industry to innovate is covered by
Altshuler's first reason, and has been highlighted by the managing director of the Motor
Industry Research Association (MIRA) (Wood, 1994). The recommendations produced
by the Royal Commission on Environmental Pollution required the automotive industry
to reinvent 'the average car'. One of the main, and most challenging recommendations
being the proposed target of a 40 per cent increase in the average fuel efficiency of new
cars by 2005. These recommendations will require an enormous amount of research and
development (R&D) into new designs for both components as well as for the whole car
design, and those with effective NPD processes will be more successful.

Another catalyst for innovation is the many different market segments which demand
different styles and features. Altshuler et al. (1984) highlights the fact that innovation in
the automobile industry must be directed towards at least four different markets: the
utilitarian consumer, who wants the vehicle to be a workhorse (from the company sales
rep's car to the farmer's four-wheeled drive cross-country vehicle); the performance-
minded consumer, seeking ever greater acceleration and sleeker styling; the economy-
minded consumer, conscious of fuel and maintenance costs and resale value, in addition
to initial price; and the luxury consumer, whose motives are a mix of comfort, delight,
ego satisfaction and public image. To these must now be added at least one further class:
the ecological or environmentally conscious consumer, although this set of market factors
appears to cut across all the previous four (Altshuler et al., 1984).

As discussed in section 2.4.1 the dematuring of the industry, highlighted by Abernathy et
al (1981), leading to a renewal of the auto industry, has also provided the need to
innovate, in order to gain and sustain a competitive advantage. Sasaki (1991) highlights
that the automobile industry is in the middle of a technological revolution which has increased the speed of competition in research and development.

2.5.3 THE NPD PROCESS IN THE AUTOMOTIVE INDUSTRY

Strategic alliances and the world-wide success of the Japanese is also having a major effect on Western automobile manufacturers. "Recent years have seen widespread moves to emulate Japanese manufacturing practices, and nowhere is this more apparent than in the world car industry" (Oge, 1990). This has been termed 'Japanisation', which may usefully be understood to refer to programmes of industrial innovation inspired by a set of standards or ideals extrapolated from some aspects of Japanese practice as perceived by some observers.

Turnbull (1988), however, identifies that there are still limits to the process of adopting JIT and other 'Japanese' practices identified with successful Japanese companies. The U.K. auto industry possesses a quite different structure which is acting as a significant restriction on the industry's capacity to emulate the Japanese model successfully. Equally problematic, however, is the inability or unwillingness of the major motor manufacturers to emulate that strategy wholeheartedly. Extensive interviews with suppliers highlighted that a major problem with the new 'partnership' arrangement between assemblers and suppliers is the lack of trust between the parties. Turnbull (1992) suggests that "Trust, collaboration and co-operation will take time to cultivated or re-establish", but that time is limited - Japanese levels of manufacturing performance appear as far away as ever, and are continuing to improve.

Turnbull (1992) comments that many have failed to recognise the extent to which JIT, as one example of 'Japanisation', is based on a specific form of union organisation and interest representation that is incompatible with British trade unionism and that they have misunderstood and misrepresented both the process and possible extent to which the 'Japanese Way' will pervade the contours and constitutions of British industry. He suggests that one can already detect potential problems ahead for firms that continue to impose new working arrangements regardless of union objections, and states that an
overriding fascination with the tactics of successful Japanese firms such as JIT deliveries, kanban, zero defects, quality circles, etc. may obscure the strategic lesson of Japan's industrial success, namely that manufacturing excellence is critical. There is more than one route to competitive success, and we should question whether the Japanese model is not only transferable but more importantly whether it is even desirable.

Turnbull (1992) goes on to state that, recent years have witnessed fundamental organisational changes both within the vehicle assemblers themselves and between assemblers and suppliers as a direct response to the Japanese challenge (Turnbull 1992).

This has been especially obvious in the buyer-supplier relationships (Wells and Rawlinson, 1994). In the U.K. 'traditional' buyer-supplier relationships was premised on stable, high volume, low variety production, relationships. The primary criterion for awarding contracts was price competitiveness. The design effort was almost always one sided, with little, if any, collaboration.

The first oil shock in 1973-74 caused major changes and marked the transition of competition as demand fell and car design 'converged' on smaller, more fuel efficient models. The focus therefore shifted towards reducing unit costs via a 'partnership' relationships, which required far greater dependency and commitment. Sole, or 'preferred' suppliers were awarded larger, longer-term contracts, allowing suppliers to engage in more forward planning. This reduced the number of suppliers and closed off of a number of direct supply lines, creating a second & third tier.

The U.K. model now resembles the Japanese model of supplier relations, which is made up of a largely dedicated supplier base consisting of an industrial grouping of affiliated companies. These major suppliers in turn create groups of subcontractors, the second and third tiers. The 'first-tier' suppliers being closely involved in product development work. The major difference between the U.K. and Japan was that the U.K. structure has a largely independent and 'shared' 1st tier of suppliers, whereas the Japanese only have a common second and third tier with some sharing of the first tier. The terms first and second tier have been widely but loosely used for some time in general descriptions of the
situation in Japan. In transferring the terminology to the west, Lamming suggests that several misconceptions arise due to the different industry structures and so suggests that suppliers may be better described as direct or indirect and aligned or unaligned suppliers, to varying degrees. He goes on to suggest that the terms ‘first and second tier’, as applied to suppliers, should be used to indicate the degree of influence the supplier exerts in the supply chain, rather than some fixed position in a hierarchy, and those who remain as 1st tier suppliers will need to provide a greater range of services to the assemblers, including research and development.

The Japanese model allows greater technological diffusion between a given vehicle assembler and its suppliers, whereas the U.K. structure creates obstacles to technology transfer and to the tight synchronisation and co-operation between buyer and supplier.

In Lamming's partnership model (1993), the structure of the supply chain is created to provide optimum combination of complementary assets in subcontracting firms - tiers of companies taking responsibility for specific parts of the manufacturing process. A supplier towards the top of this tiered structure has a solid, long-term relationship with its customers, which is not set/provided by right but by fulfilling expectations. In order to fulfill this highly demanding role, suppliers need to use all available resources - including the abilities of other suppliers. i.e. co-operation and efficient information exchange are of fundamental importance. Lamming suggests that "in the partnership model suppliers become involved in the new product development process very much earlier than before".

Ali et al. (1994) also identified early involvement and closer integration of suppliers in new product development as one of the important developments in the way inter-firm relationships are now handled. Ali suggests that suppliers are being identified and involved in new product development by assemblers at a much earlier stage than previously, in order to shorten the product development time and capitalise on supplier-originated innovations and technical know-how.

However, Turnbull (1988) notes that "the high-dependency manufacturing strategy of the Japanese vehicle assemblers is facilitated, and perhaps only permitted, by the structure of
the industry", and identifies that, at present, the vehicle assemblers appear to be pursuing the advantages of the Japanese model whilst paying insufficient attention to the conditions necessary to support it.

However, the inspiration from the East has caused this process to accelerate. The vehicle manufacturers began reassessing their whole approach, asking whether it was really cost-effective to do all design and development in-house (Daniels, 1996). Many vehicle manufacturers have now concluded that they want worldwide suppliers to prove fully-designed and developed sub-systems and this has, “increased pressure on suppliers to adapt, or slip a couple of links down the supply chain” and it is foreseen that this process will only accelerate over the next few years (Phelan, 1997:71).

2.6 SUMMARY AND IMPLICATIONS OF PAST RESEARCH

The literature review carried out has identified much valuable information for the current research. Many important factors for success have been identified by past research, which despite variations in methodologies, have tended to report reasonably consistent findings. However, these studies have been persistently exploratory and do not tell which set of factors, as a package, lead to improved development performance (Montoya-Weiss and Calantone, 1994). Another issue is that this wealth of literature on general success/failure factors is contrasted by the lack of focused literature on more specific aspects of NPD.

The literature also highlights that there are still problems with the NPD process models and how they are implemented by firms. Despite all the research, it is widely held that new products are still failing at an alarming rate (Cooper, 1995; Wind & Mahajan, 1981). Cooper (1995:334) concludes that "the new product process is very much in trouble, plagued by errors, omissions and doubtful quality-of-execution. The time is ripe to look at one's innovation process".

In-depth research into the development process activities would provide a better understanding of how the process can be improved which would then enable firms to
develop new products with shorter lead times and with less risk of failure (Craig and Hart, 1992).

The literature also identifies that there is a need to study individual industries. Many researchers have focused their investigations on a variety of industries. Other studies have concentrated on a single industry, or business area in an attempt to find out if the general consensus of critical success factors holds true for a particular instance. (Voss 1985; Maidique & Zirger 1984; Rothwell et al 1974). These studies in a variety of countries have produced remarkably consistent results, which is encouraging. However, Cooper and Kleinschmidt (1993a) suggest that this could be the consequence of “averaging” of results across industries and country boundaries. Craig and Hart suggest that this could also be explained by the fact that researchers are clearly influenced by previous studies from which they derive their variable set, perhaps to the exclusion of other important factors (Craig & Hart 1992). As a consequence, very similar variables are examined, regardless of whether they are appropriate, leading to a series of highly inter-correlated results. A study that gives weight to this concern was undertaken by Link (1987), who used open-ended questions to ask respondents to cite any additional critical success factors. It unearthed three new factors which had not previously been identified.

The UK automotive components industry was chosen because it provides an interesting area for study due to the significant changes taking place in the structure of the automotive industry as a whole. These changes are driving suppliers to focus on product design and development as a basis for competition. Vehicle Manufacturer’s (VM’s) are moving towards a more systems-oriented approach in which a limited number of systems suppliers or systems integrators - with design, engineering, and other advanced capabilities - supply fully assembled and tested modular systems. The ability of Component Suppliers to develop new products successfully will be critical to their survival in the industry.

Another issue raised in the literature is that the type of new product development investigated (i.e. the product’s innovativeness) affects the c.s.f. identified (Craig and Hart,
1992; Kleinschmidt and Cooper, 1991 and researchers need to identify which types of NPD projects are being investigated.

Finally, recent research has also identified that there are different types of success associated with different NPD strategies and that the way in which success is defined influences what c.s.f. will be identified by any research. (Hart, 1993).

Therefore, there is a need to confirm that the measures used in future studies to gauge the performance of NPD projects are both comprehensive and, due to the contingent nature of new product development (Craig and Hart, 1992), appropriate for the industry under investigation.

Whilst useful insights can be gained on the key variables which affect NPD, it can be concluded that the present literature does not provide a sufficiently comprehensive understanding of the specific development process activities or how success measurement affects the c.s.f. identified, or whether NPD is contingent, i.e. determined by the project, the company, and the industry in which development is taking place (Craig and Hart, 1992).

Because of the problems associated with past research which have been highlighted in a number of recent studies (Craig and Hart, 1992; Montoya-Weiss and Calantone, 1994) and the fact that the research is being extended into a new industry and different culture, it was decided that a qualitative study would be required to investigate the specific detail of NPD in this industry and ensure that the measures used were appropriate for the industry under investigation.

The aim was to supplement the knowledge obtained from the literature with field-based observations, prior to developing a conceptual model for the main study. This exploratory research will be explained in detail in Chapter 3.
CHAPTER 3
EXPLORATORY STUDY

As already identified in Chapter 2, there is a well-established body of literature for NPD. However, Craig and Hart (1992) identify that the NPD process is, ultimately, determined by the industry in which the development is taking place. Douglas and Craig (1983) also important to establish that the measures and constructs used are reliable and valid for the industry under investigation. The literature was thought insufficient to be able to clarify the internal NPD process concepts required.

The choice of an exploratory research design was justified on the basis that relatively little is known about the problem (Churchill, 1995) and that "no acceptable, valid and reliable quantitative measurement exists" (Patton, 1980:75).

Therefore, the first step in the research process was to develop a more complete understanding of the industry specific information for the development process activities undertaken and the performance measures used by Automotive Component Suppliers.

The remainder of this chapter describes this exploratory study. First the research design will be discussed, then the research instrument used, next the analysis strategy is described and finally, the results of the study are discussed and placed in context of the literature review (chapter 2).

3.1 STUDY DESIGN

Douglas and Craig (1983) identify the danger of assuming a previously developed construct or measure will work in a different cultural or industry setting. It is also necessary to: examine the appropriateness of the data collection methods; establish the content validity of the concepts; and assess the usefulness of the measures and constructs in an Automotive Industry context. Thus, the aim of the study was to “discover significant variables in the field situation, to discover relations among variables, and to lay a groundwork for later, more systematic and rigorous testing of hypotheses” (Kerlinger, 1964:388). The interview provides the best opportunity to do this as it is “.... the opportunity for the researcher to probe deeply to uncover new clues, open up new dimensions of a problem and to secure vivid, accurate inclusive accounts that are based on personal experience” (Burgess 1982:107).
3.1.1 KEY INFORMANT INTERVIEWS

A key informant survey (Phillips, 1981) was selected as the appropriate method of data collection to tap the knowledge and experience of those familiar with NPD within automotive component companies (Churchill, 1995).

A total of 10 interviews were carried out on managers from 10 automotive components companies across the UK. The respondents targeted were R&D Directors, R&D Managers, NPD Managers, or Project Managers, whoever had a responsibility for NPD within the particular firm. The small sample size was justified given the preliminary nature of the investigation, the purpose of which was to provide greater insights into the well documented and conceptualised research area of NPD practices, rather than generalisability (Denzin, 1994). However, the research design chosen can provide the means to make sense beyond the specific cases discussed (Miles and Huberman, 1994).

The research made use of The Motor Industry Research Association, MIRA (the project's sponsors), whose endorsement enhanced the project's credibility when soliciting co-operation from firms. In the same vein, The Society of Motor Manufacturers and Traders (SMMT) was contacted and the research topic formally presented to them. They also verified the importance of the research for Automotive Component Suppliers and provided support by supplying a list of their members including named contacts, although these were not necessarily the appropriate person for this study.

A 'judgement sample' was used to identify firms known to be able to contribute. This process was aided by the expert industry knowledge of MIRA, who helped with the choice of respondents. This method was chosen because "as long as the researcher is at the early stages of research when ideas and insights are being sought or when the researcher realises its limitations, the judgement sample can be used productively" (Churchill, 1995:583). However, this sample also incorporates some measure of convenience sampling due to the fact that they were thought, by MIRA, to be more likely to co-operate and also due to the problems associated with obtaining access to busy managers (Malhotra, 1996). However, every effort was made at the selection stage to ensure that the respondent firms were representative of UK Automotive
Component companies known to be undertaking NPD and that they varied in terms of both size and product sectors (see Table 3.1).

This sampling could have reduced the representativeness of the data collection at this stage, but, as Singleton et al (1993: 165) remark, the use of non-probability sampling for the collection of qualitative data is not a problem, they argue that, "under these circumstances generalising to a specified population and estimating sample precision are usually unimportant or irrelevant". Churchill (1995) also advocates the use of non-probabilistic sampling in an experience survey, as it is not appropriate to interview people who do not have relevant experience or the ability to articulate this knowledge.

The named SMMT contacts were first approached by telephone to identify appropriate respondent(s) - "since the appropriate respondents ... are often difficult to identify and may encompass many parts of an organisation" (Aaker & Day, 1990:164). The telephone call outlined the project details, along with the names of supporting organisations and a meeting arranged. If the person called was not the correct contact they were asked to identify who in their company would be. They were then contacted and a meeting was arranged. The author was careful to ensure that the times of the interviews were arranged to minimise the likelihood that the interviewee would become impatient (i.e. end of day) (Hart, 1989). The initial contact call was followed by a letter detailing the date and time of the arranged meeting, re-iterating the support for the study and what the interview would be trying to achieve (Easterby-Smith et al., 1991). It also reiterated that information provided during the interviews would be absolutely confidential (Churchill, 1995; Oppenheim, 1992).

### 3.1.2 INTERVIEW SCRIPT CONTENT

The interviews aimed to obtain insights into:

- the company characteristics of the firms interviewed, such as: firm size, product sectors, and strategy;
- the types of new product development undertaken by these firms and the extent to which the process is influenced by the project type;
- the performance measures used by the firms to rate the success or failure of their development projects;
• the specific internal process variables, and whether these are influenced by any other variables;
• the market characteristics and their possible affects on the firms NPD process.

These areas were identified from the literature (Chapter 2) as issues requiring further exploration and were used to develop questions to be included in a semi-structured, undisguised interview schedule. However, this schedule was only used as a rough guide, enabling the interviewer to react to the individual situation whilst following a general outline of research questions (Malhotra, 1996). This need for structure, particularly to allow comparison between organisations and to enhance the validity and reliability of the research, had to be balanced with the flexibility needed for exploratory investigation (Patton, 1980; Denzin, 1978). Such flexibility was considered important because all too often researchers “enter the field with preconceptions that prevent them from allowing those studied to ‘tell it as they see it’” (Denzin, 1978:10). A direct/undisguised approach was adopted for the interviews, i.e. the objectives of the study were not hidden from the informants (Churchill, 1995; Malhotra, 1996). The interview schedule used can be found in appendix 3.1.

All the management interviews lasted approximately one hour and there was no apparent reticence in answering any questions. The interview began with an introduction of the interviewer and the study’s objectives. At this point respondents were again assured that the information provided would be strictly confidential.

In order to avoid taking notes during the interviews the respondents were asked whether they minded being recorded. All but one interviewee agreed to have the interview taped. For this interview notes were taken and in order to maintain the accuracy of the data the notes written up straight after the interview. However, notes were also taken during the other interviews where extra information was provided, i.e. non-verbal data both in the form of diagrams and body language/expressions (Easterby-Smith et al., 1991, Miles and Huberman, 1994).

Given the exploratory focus of the study, the fieldwork was seen as a continuous learning process, with knowledge gained from each interview being used in subsequent interviews to improve the focus (Miles and Huberman, 1994). However, it was found, after reviewing the first five interview transcripts, that responses were very similar. It was evident after ten had been completed that no new ideas or items were
emerging. Mahoney, Thombs & Howe (1995) suggest that the investigator intensively collects information from the key informants and is free to enlarge or shrink the 'sample size' depending on whether the answers reach a point where nothing new is being found.

3.2 ANALYSIS STRATEGY

Many of the procedures put forward for analysing qualitative data are both time consuming and costly (Easterby-Smith et al, 1991) and are most useful for a large volume of unstructured, in-depth data. Miles and Huberman (1984) put forward a method of analysing semi-structured questionnaire data "that is both simple and rigorous" (Easterby-Smith et al, 1991: 112) The method is appropriate when the researcher has a good knowledge of the area of interest from the conceptual framework but felt that a greater insight into the area was required in order to identify new items of interest.

Miles and Huberman (1994:10) "define analysis as consisting of three concurrent flows of activity: data reduction; data displays; and conclusion drawing/verification. They suggest a two-stage analysis, starting with a within-case analysis of each firm. Then, after integrating the findings of individual analysis into a systematic data display, a cross-case analysis (Figure 3.1). These steps are necessary because working with original transcripts can overload the data processing abilities of the analyst (Faust, 1982).

**Figure 3.1 - Analysis Strategy**

- **Transcription of tapes**
  - During Interviewing Period
  - After Interviewing Period

- **Within-case analysis**
  - Coding
  - Data Displays

- **Cross-case analysis**
  - Cross-case Displays

- Discussion

3.2.1 WITHIN-CASE ANALYSIS

The processing of field notes can be problematic and transcription of tapes can be done in many ways that will produce rather different texts (Miles and Huberman, 1994). Therefore, after each interview the tapes were transcribed verbatim to produce an unbiased record of the interviewees responses (Easterby-Smith et al., 1991) and reviewed as part of the continuous learning process (Miles and Huberman, 1994). These transcripts were then coded after completion of all the qualitative interviews which is considered a better method than coding after each individual interview, because there is a danger that otherwise “the new data collected to verify the pattern are being sought out selectively” (Miles and Huberman, 1994: 70). A provisional list of basic descriptive codes derived from the NPD literature were applied to transcripts following the procedures recommended by Huberman and Miles (1994). However, “rigid use of literature-based codes could have restricted the analysis to what was already known” (Diamantopolous & Souchon, 1996:124). Therefore, not all codes were pre-specified. New insights were allocated additional codes as they emerged (Miles and Huberman, 1994). To reduce the data to a more manageable size, outputs were produced for each firm generating 10 standardised displays. These provided “a visual format that presents information systematically, so the user can draw conclusions” (Miles and Huberman, 1994:91) (see Appendix 3.2 for an example).

3.2.2 CROSS-CASE ANALYSIS

Cross-Case Analysis aims to increase the generalisability of the findings of qualitative information, and provide potential for greater explanatory power than a single-case study (Glaser and Strauss, 1967) by integrating and synthesising the company level displays into fewer cross-case displays. The methodological literature identifies two approaches to cross-case analysis (Ragin, 1987). The first is a variable-oriented approach (e.g. Runkel, 1990) which focuses on within-category sorting, i.e. one variable across all cases. The second is a case-oriented approach (Denzin, 1989; Ragin, 1987) which focuses on “one single case in-depth, and then successive cases are examined to see whether the pattern found matches that in previous ones” (Miles and Huberman, 1994:174). There is also a third strategy, the mixed strategy. This is a
combination of case-oriented and variable-oriented approaches (Miles & Huberman, 1994). The first is more appropriate for this study given that the study’s objective was to identify themes and individual items within well-known categories rather than to provide in-depth descriptions of individual firms (case-oriented strategy) or derive generalisations by contrasting firms on standard variables (mixed strategy). Therefore, the within-case displays were reduced to produce conceptually ordered meta-matrices, which are master charts assembling the descriptive data from each of several sites on one sheet, which captured in a few words the most important issues for each code (Miles and Huberman, 1994).

3.3 QUALITATIVE FINDINGS

Managers identified many of the original indicators suggesting that they were appropriate for use in this study. They also identified some measures that needed modifying, as well as some completely new measures for this industry, especially for the development process stage, which is the focus of the study. These will be elaborated below, highlighting where they conform to previous study findings and where they provide new insights into the variables associated with NPD success and failure in the industry investigated.

First, the general characteristics of the firms interviewed will be identified. Then the types of product development the firms undertake and the affect on the development process. Next the performance measures used by the firms will be identified and finally, the internal process variables will be examined.
<table>
<thead>
<tr>
<th>Firms</th>
<th>Corporate Status</th>
<th>Sales</th>
<th>Employees</th>
<th>Product Sectors</th>
<th>NPD Projects</th>
<th>Strategy</th>
<th>Corporate Synergies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 of 6 product sectors in a larger corporate business sector</td>
<td>Automotive $3.8 world-wide for 1996</td>
<td>Company Total - 36,000</td>
<td>Safety Restraints</td>
<td>24 projects for their single product sector</td>
<td>Growth through innovation, acquisition, globalisation and productivity improvements</td>
<td>market research and engineering skills, distribution resources, etc.</td>
</tr>
<tr>
<td>2</td>
<td>UK operation of a large Japanese corporation</td>
<td>Corporate sales - $350m</td>
<td>N/A</td>
<td>Exhaust/ Heating exchange systems</td>
<td>N/A</td>
<td>Gain competitive advantage through technological collaboration</td>
<td>market research skills, financial, distribution and R&amp;D resources</td>
</tr>
<tr>
<td>3</td>
<td>1 of 4 business units in larger automotive operating division</td>
<td>Automotive Division £396m</td>
<td>Business Unit - 100</td>
<td>Engines and engine components</td>
<td>N/A</td>
<td>Market leadership through innovation and specialisation.</td>
<td>market research, engineering skills, distribution and financial resources</td>
</tr>
<tr>
<td>4</td>
<td>1 of 6 operating divisions in a large automotive group</td>
<td>Automotive group - $26bn Div. $78m</td>
<td>Auto Group 179,000 Div. - 26500</td>
<td>Braking and suspension systems</td>
<td>10% Blue sky; 30% Genuine NPD; 60% Engineering Applications</td>
<td>Global expansion, esp. East Europe, through acquisition and vertical integration</td>
<td>market research, R&amp;D and engineering skills, distribution and production resources</td>
</tr>
<tr>
<td>5</td>
<td>Sales subsidiary of 1 of 3 corporate divisions</td>
<td>£160m 1996</td>
<td>Globally 64,000</td>
<td>Air conditioning, heating, and engine management systems</td>
<td>Most R&amp;D at head office but increasing scope and ability locally (1 - 2 projects per year)</td>
<td>Corp. Globalisation, customer satisfaction and environmental preservation</td>
<td>market research, R&amp;D and engineering skills, distribution and financial resources</td>
</tr>
<tr>
<td>6</td>
<td>1 of 3 divisions in 1 of 4 business areas for large, diverse corporation</td>
<td>Auto $5,358 for 1996 up 35%</td>
<td>Auto Group 33,000</td>
<td>Seating systems</td>
<td>35 development projects on-going (1996)</td>
<td>Market leadership through joint venture, acquisition and continuous improvement</td>
<td>market research, R&amp;D and engineering skills, distribution resources</td>
</tr>
<tr>
<td>7</td>
<td>1 division of 7 from top 10 automotive component supplier</td>
<td>Auto £2,461m 1996 £2,210m 1995</td>
<td>N/A</td>
<td>Braking, Electrical &amp; electronic engine</td>
<td>N/A</td>
<td>Gain advantage through technology, financial strength and collaboration</td>
<td>market research, manufacturing skills, distribution resources</td>
</tr>
<tr>
<td>8</td>
<td>UK based subsidiary of 2 divisions in 16 in large automotive firm</td>
<td>UK £160m</td>
<td>World-wide 23,000 UK 1,600</td>
<td>Lighting and alternators</td>
<td>12-16 per year in one area</td>
<td>Globalisation, New technology Joint ventures</td>
<td>market research, R&amp;D and engineering skills, distribution, financial and manufacturing resources</td>
</tr>
<tr>
<td>9</td>
<td>Auto equipment part 1 division of 3 in larger group</td>
<td>Division 2 FRF bn approx.</td>
<td>Division - 460</td>
<td>Engine management systems</td>
<td>3 major development projects in 1 year</td>
<td>Creating competitive edge in niche markets</td>
<td>market research skills, distribution resources</td>
</tr>
<tr>
<td>10</td>
<td>1 of 2 groups in an Automotive division that is 62% of a large, diverse multinational corp.</td>
<td>Corp. Sales $10.2bn Automotive $6bn</td>
<td>Corp. 66,000 Group 2,040</td>
<td>Steering, suspension systems, occupant restraint systems and engine components</td>
<td>N/A</td>
<td>Globalisation and market leadership through innovation and joint development work</td>
<td>market research, management and engineering skills, distribution, financial and production resources</td>
</tr>
</tbody>
</table>

Note: N/A = information not available
3.3.1 CORPORATE CHARACTERISTICS

The firms interviewed, whilst all being divisions of larger, multi-national corporations, were very varied, both in size and product sectors (Table 3.1). The product sectors represented include: Exhaust systems; Braking and suspension systems; Heating systems; Lighting; Engine Management systems; Occupant Restraint Systems; and various engine components. Corporate sales ranged from 2 FRF bn (equivalent to $400m) to $26 bn. The smallest firm had 79 employees and carried out very little genuine new product development, “maybe only 1 or 2 projects per year” (Firm 5). The largest had 26,500 employees, with over 1,000 in seven specific R&D technical centres, spending $84m on developing 'genuine new products' (Firm 4).

Overall the corporate strategies adopted by most of the companies interviewed were very similar. Unsurprisingly, given the industry environment, global expansion was explicitly stated as a core strategy by five of the ten firms. Most suggested that growth would come through innovation/developing new technology (7 out of 10 firms). Six firms also suggested joint ventures or acquisitions as a means of increasing their market share. R&D spend, as a percentage of turnover, was also similar across the 5 firms willing to provide information, all between 4-6%.

In terms of the synergies between these corporate characteristics and the firms project capabilities all the respondents identified that only market research and distribution resources were important marketing synergies. Advertising, sales, promotion and customer services were not seen as applicable for this industry. In terms of technical synergies, R&D/product development skills, engineering skills and manufacturing/production resources were all identified as important determinants of successful NPD.

3.3.2 WHAT TYPES OF NPD PROJECTS ARE UNDERTAKEN?

An issue raised in the literature is that the type of new product development investigated (i.e. the product’s innovativeness) affects the factors identified (Craig and Hart, 1992). It was, therefore, important to identify what types of NPD projects were undertaken in the Automotive Components Industry in order to ensure that the data collected would be comparable. Three distinct types of development projects were identified by the interviewees:
1. engineering applications (Firms 1,2,3,4,5,6,9,10), which are usually simple reformulations of a product for a new model of car. “No new technology is used, these projects only apply existing technology to a new model of car” (Firm 2). These are suggested to be the majority of projects undertaken (Firms 1,2,4,5,10). However, the interviewees did not agree on whether these actually undergo a complete development process or not. One manager suggested that “they only require a small amount of development, the rest is all testing and validation” (Firm 9). Other interviewees, however, put forward the opposing view that “even though these products are only simple extensions they still have to go through a full development cycle” (Firm 2).

2. ‘Genuine’ new products, (Firms 1,2,3,4,6,8,9) i.e. a product that has not been manufactured before but is using currently accepted technology, though not necessarily from the automotive industry. They also use technology from aerospace and the chemical industry (Firm 4).

3. ‘Blue Sky’ projects (Firms 2,4,6,8,9,10), which incorporated new technology, are usually more than 5 years away from the customer and often involve atypical development processes.

These categories are more general than the ones suggested by the literature. Booz, Allen and Hamilton (1982) describe 6 different categories of new products based on their degree of newness: “new-to-the-world products”; “new product lines”; “additions to existing product lines”; “improvements/revisions to existing products”; “repositionings” and “cost reductions”. However, despite the different terminology used, the categories identified from the interviews can be seen to incorporate one or more of these categories highlighted from the literature. The engineering applications projects include: additions to existing product lines, improvements/revisions and repositionings, although these are very unusual in this industry. This leaves ‘genuine new products’ which are the equivalent to ‘new product lines’, as well as ‘blue sky’ projects which fit with the ‘new-to-the-world’ product category. Cost reduction however, was identified as relating to both ‘engineering applications’ and ‘genuine new products’, and was seen more as an objective of development projects rather than the only reason for undertaking a development project.
Customer/Marketplace Measures

Four of the six measures suggested by Griffin and Page (1996) were cited by the managers interviewed:

- market share
- unit volume goals
- customer satisfaction
- customer acceptance

Whilst identifying two measures by which projects have been judged, one manager also highlighted the situational nature of these performance measures as discussed by Craig and Hart (1992). “Four years ago market share was very important because the company wanted to get a foothold in Europe. They have now achieved this and are keen to start making money” (Firm 6). Contrary to findings from Griffin and Page (1996) however, none of the firms measure their new products against either revenue goals or revenue growth goals.

Technical

Most firms interviewed measure their projects against quality targets. However, where Griffin and Page (1996) identify one overall measure of quality, three of the firms (3,6,10) identify two separate measures of quality, product reject levels (i.e. internal scrap or rework in parts per million (PPM), and warranty levels, i.e. “faults reported by customers/end users after sale of the whole car” (Firm 6). The second was identified as more important because of the associated costs, both of replacing the part at the dealers, and in terms of the effect on customer perceptions.

Firm 9 also discussed a measure of the opportunity the project gives the firm in terms of entering a new market or new product. These measures have been used in previous studies (Cooper and Kleinschmidt, 1987c; Parry and Song, 1994) but were not found to be used by managers in the study by Griffin and Page (1996). It is not clear at this point which performance dimension these two measures belong to.

In summary, these findings are encouraging and important in that the measures fit within the previously identified categories. However, what is also clear is that within these categories certain measures which are applicable in one industry will not necessarily be as important in another industry. They may focus attention on other
measures when determining the success or failure of a development project. This gives weight to the idea that performance measures, like many of the other antecedent variables, are industry specific (Craig and Hart, 1992; Souder, 1987; Balanchandra and Friar, 1997).

Figure 3.2 - Display Chart for Internal Development Project Variables

3.3.4 INTERNAL PROJECT VARIABLES

Figure 3.2 summarises the findings on the internal factors relating to the development of new products in the firms participating in the study. The shaded areas all relate to the new product process, but have been separated into smaller sections for clarity. All these constructs are elaborated below, and where necessary, contrasted with the variables used in past studies on characteristics for success in NPD.

78
Project Organisation

The need for cross-functional integration in NPD activities is well established (Griffin and Hauser, 1993; Song and Parry, 1992) and most firms interviewed utilised multi-functional teams when developing new products. Some went further stating that there should be a ‘core’ team responsible for the project from beginning to end which is consistent with the findings of Kleinschmidt and Cooper (1995). However, this can be problematic for smaller firms who do not have the resources to have dedicated teams for each project (Firm 2, 4, 6, 9). Firm 6 identified that their team members can have conflicting priorities due to being on more than one development team at any one time.

These teams should be led by a project manager or “one person who was a strong driver and leader of the project” (Firm 3). Again this conforms with current literature (Kleinschmidt and Cooper, 1995; McDonough and Leifer, 1986; Larson and Gobeli, 1989). A problem noted by two firms was that this structure only aided successful NPD if the manager had: “sufficient authority” (Firm 6), or “full responsibility and accountability” (Firm 4).

Joint ventures also seem to be very important for the automotive components industry, especially when the components are part of a larger system or ‘mate’ closely with other components (Firms 1, 6, 7, 8, 10). Two firms, however, thought it more important to look at vertical integration and have been buying up strategic suppliers in order to keep core competencies in-house to retain control (Firms 4 & 7). It was also seen as important by some firms that customers be “actively involved in the risk sharing and management of the project” (Firm 10). Firms are also looking to involve universities and independent organisations in these project partnerships: “we see universities as a useful partner and work with various research bodies to answer questions. We value their independence” (Firm 10). They are seen as a means to “increase the knowledge base without the costs associated with doing this up-front “homework” (Firm 6).

Communications, both internal and external to the project team were cited as important to achieving successful new products. This is again consistent with previous studies (Pinto and Pinto, 1990; Johne and Snelson, 1987; O’Hare, 1988).
The level of communication and integration, through joint ventures, was also seen to affect the development process activities the firms undertake (Firms 1,6,8,9,10). “Some customers are highly involved in the development process and we have to alter our development process to fit with customers” (Firm 10).

Project organisation is, therefore, partially determined by the corporate characteristics of the firm (Firm 4,6,10) as well as the source of the new product idea (1,2,4,10) and in turn affects the development process activities undertaken (Firm 1,6,8,9,10).

**New Product Strategy**

Many of the elements of Product Advantage and Non-Product Advantage were found to be consistent with previous studies. However, some were identified as being unimportant in this industry, such as: designed for world-wide use; being adjustable to specific customer requirement; the risk of purchase for the customer; whether the product does a unique task for the customer; superior service and technical support; salesforce advantage; and advertising advantage. It was also identified that the project strategies followed were affected by both, the firm, and the market environment characteristics.

**Source of the New Product Idea**

“The process of new product development involves the activities and decisions from the time when an idea is generated (from whichever source) until the product is commercialised (launched into the market)” (Craig and Hart, 1992:20). The source of the new product idea is very important to the successful outcome of a development project. “Ideas are the raw materials for product development, and the whole planning process depends on the quality of the search and screening process” (Rochford, 1991:287). Unfortunately, despite its importance to the success or failure of new products, questions addressing this issue are often omitted from studies. Past research tends to only address the development process at the initial screen (Cooper and Kleinschmidt, 1986; Kleinschmidt and Cooper, 1995; Calantone et al, 1996; Parry and Song, 1994; Song and Parry, 1996). The importance associated with the source of the project ideas was identified early on in the data collection by Firm 8, who suggested that both internal and external, market environment sources of new product ideas could lead to successful new products. This issue was then incorporated in all the
subsequent interviews. Later interviewees identified five different external sources of new product ideas, which were: customers; competitors (both joint ventures with competitors which are rare but have begun to occur (Firms 7,8) and reactions to competitors innovations (Firms 1,8)); suppliers; other industries; legislation. The source of the new product idea was also identified to affect project organisation (see earlier) and the development process. “When other organisations have a stake in the project they tend to become involved in the whole process, which can affect how the product is developed” (Firm 8).

**Development Process Activities**

The actual activities carried out during product development in the firms interviewed could be categorised into four main stages: pre-development activities; the development process, including design and development, prototyping and tooling; testing and validation; and market launch. These overall stages are more general than many of the process models suggested in the literature (Booz et al, 1982; Cooper, 1994; Kotler and Armstrong, 1994), however, within these stages they are far more detailed, as outlined in Figure 3.2. Whilst it is accepted that some of these findings are industry specific, the overall message is that NPD is much more complex than many of the models presented by past literature, providing support for a suggestion by Craig and Hart (1992) that their simplistic nature has made them harder for practitioners to implement.

All the pre-development activities were seen to be grouped together when firms discussed their development processes. Three distinct sub-sections of the product development stage were identified: product design/development; process design; and prototyping and tooling. The last two are a reflection of the industry under investigation. The key findings for each of the development stages identified in Figure 3.3 are summarised below.

**Figure 3.3 - Stages in the Development Process Models of Firms Interviewed**

![Diagram of Development Process Stages](https://via.placeholder.com/150)
Pre-development Stage Activities

*Market and Technical Assessment.* All of the firms interviewed identified that “understanding the potential customer’s needs, wants and specifications for the product” (Firm 8) was vital to developing a successful product. However, where some firms thought that this should be in the form of “broad wish lists at this stage” (Firms 2, 7), others insisted that these should be well documented including “carefully defined specifications” (Firm 1). Two firms highlighted the use of customer clinics (6, 9) and others also advocated doing extensive benchmarking of competitors products (Firms 1, 2, 6). The importance of understanding all the technical issues, such as: the manufacturing process and associated costs; the process technology and equipment; feasibility studies of developing and manufacturing the product; and even “possible sourcing alternative” (Firm 4), were identified by some firms as being critical to project success, especially in terms of being ‘within budget’ and ‘on time’. These findings are far more detailed than past research studies due to the focus of the research.

*Concept Generation* - when the product concept is developed (Hollins and Pugh, 1990). Having a carefully designed and comprehensive product design specification (PDS) at this stage was thought to be important (Firm 1, 3, 4, 5, 6, 10). This finding is unsurprising given that past research always identifies that having a well defined project prior to the development stage is critical to success (Cooper and Kleinschmidt, 1987a; Hollins and Pugh, 1990).

*Screening* - is the first review of the proposed project (Kleinschmidt and Cooper, 1995). Many of the firms had formal review process for screening new products (Firms 2, 3, 4, 7, 8, 9). Generally, this stage also included a business and financial analysis which led to a Go/Kill decision prior to the development phase. Projects need to be evaluated against business implications at this stage (Firms 1, 2, 7, 9, 10).

*Project Planning.* “Establishing a timetable for the subsequent product development stages” (Firm 3) was identified by many firms (3, 4, 6, 9), some even included the need to define team member responsibilities, a factor also supported by findings in the Project Organisation section relating to project team members and authority. In
agreement with Cooper (1994) some firms even establish “milestones” (Firm 4) for measuring the performance and progress for each stage of the development process.

Development Process Stage Activities

*Design/Development.* All interviewees identified the importance of carrying out extensive analytic and predictive work using CAD/CAM tools, as well as FMEA (Failure Mode Effect Analysis) techniques. This was seen as vital if the development process is to be speeded up. This is very important to the Automotive Industry who have been reducing product development times down from an average of 5 years to nearer 2 - 2½ years, and even, in some cases, 11 months (Firm 6). This has also been identified by the NPD literature as an important issue for all firms developing new products (Cooper, 1994; Takeuchi & Nonaka, in Dolan, 1991). In keeping with the NPD literature, a number of firms identified that the products were developed with manufacturing in mind as well as the performance specification (Firms 4,6,10), with the manufacturing process being developed in parallel with the product development.

*Prototyping and Tooling.* Prototyping is the building of model parts prior to testing. Tooling is the acquisition of the required manufacturing tools. The firms interviewed had very different views with respect to when to start building prototypes. Some insisted that detailed drawings should be completed before beginning any prototyping. Others suggested that they started producing prototypes early on in the development process (3,4,10), even as early as the concept generation stage (Firm 10). One firm thought that less prototyping was required due to better predictive tools e.g. 3D CAD/CAM (Firms 2,3), saving firms both time and money. What made all these viewpoints clearer was a comment from the commercial manager at Firm 3, who identified that “the number of prototypes required often varies depending on the customer, e.g. Far East vehicle manufacturers favour the more traditional route of early production of prototypes”. This differing of views again showed in the tooling stage of the development process. Some managers insisted that all product and process designs and development should be completed before committing resources for implementation (7,10). Others stated that Vehicle Manufacturers wanted to see full production parts early on in the development process (Firms 4,6,9)
Testing and Validation Stage Activities

Testing and validation is required to ensure that the product works as it is supposed to. The interviews identified two types of testing/validation: those relating to the product and those relating to the process. It is essential in this industry to ensure that the product is rigorously tested against numerous benchmarks. Tests are carried out on the individual component (known as ‘benchmarking’) and also testing of the product ‘in-vehicle’. It is also important to fully test and validate the manufacturing process to ensure that product quality and volume can be maintained (3,6,9) and also to ensure that the employees are trained on the new process (6,7,10).

Market Launch Stage Activities

This is one of the issues which recurs as a consistent correlate of new product success (Cooper and Kleinschmidt, 1987a; Craig and Hart, 1992; Hultink et al., 1997; Johne and Snelson; 1988; Lilien and Yoon, 1989; Montoya-Weiss and Calantone, 1994). However, the items found were different to these previous studies. This is due to the industry under investigation. Most products do not reach this stage in their development without having a specific customer already on-board. Therefore, decisions about price and distribution have already been made. Promotion is rare, and thus, not appropriate for this industry. The only issues to address when launching products relate to the actual supply and attributes of the product, such as: the product satisfied customer delivery schedules (Firms 1,6); satisfied quality and legislative requirements (1,2,3,4,5,6,7,8,9,10).

In summary, it can be seen that the new product process is far more complex than can be understood from asking only 13 questions (Cooper, 1979b; Cooper and Kleinschmidt, 1987a; Mishra et al, 1996; Parry and Song, 1994).

3.4 VALIDITY AND RELIABILITY OF QUALITATIVE DATA

In qualitative research, issues of instrument validity and reliability ride largely on the skills of the researcher (Miles & Huberman, 1994). The lack of structure can make the results susceptible to the interviewer’s influence and the information can be difficult to analyse (Churchill, 1995). Easterby-Smith et al (1991:41) state that the validity of qualitative research can be evaluated by asking the question: “Has the researcher gained full access to the knowledge and meanings of informants?”. Other
researchers separate validity into two, internal and external validity (Churchill, 1995; Miles and Huberman, 1994). Internal validity is measured, they argue, by ascertaining whether or not events have been uncontrolled and unmodified by the researcher’s presence and action. It refers to the ability of the researcher to attribute the effects observed to the experimental variables not to other factors (Churchill, 1995). While it is impossible to state unequivocally that the researcher’s presence did not affect the data collected, the confidentiality of the participants was emphasised at all times (in telephone calls, letters and at interview) in order to increase the likelihood of obtaining unmodified answers. External validity is related to whether or not the results can meaningfully be transferred across cases (Kennedy, 1979) and can be generalised i.e. be “expected to occur in other settings” (Churchill, 1995:202). As discussed in section 3.2.1 the objective of the study was to provide greater insights into a well documented and conceptualised research area, rather than generalisability (Denzin, 1994), however every effort was made during the choice of respondents to ensure that they were representative of the industry and, therefore, likely to provide universal findings.

Reliability of qualitative data is centred around the question “Will similar observations be made by different researchers on different occasions?” (Easterby-Smith et al, 1991 : 41) and is a necessary condition for validity (Churchill, 1995). The use of a semi-structured approach to the data collection attempts to address this issue by reducing the interviewer’s influence whilst still allowing the interviewee to discuss any issues they wished to. However, the amount of change taking place in this industry, as discussed in the literature review (section 2.5.3; Chapter 2), could damage the reliability of the study. Clearly the researcher can not allow for these changes but, an acknowledgement that these changes may affect the reliability of results is important. Additionally, the problem of subjectiveness involved in the analysis of qualitative data must also be acknowledged. The rigorous qualitative research methodology used throughout the collection and analysis of the exploratory data allows the researcher to consider that the study has been done with reasonable care (Miles and Huberman, 1994).

Reliability and validity have been of prime concern to the researcher throughout the research but may have been weakened by the need to fit in with the practicalities of
organisational life. As Buchanan et al (1988:54) write, “whatever carefully constructed views the researcher has of the nature of social science research, of the process of theory development, of data collection methods, or of the status of different types of data, those views are constantly compromised by the practical realities, opportunities and constraints presented by organizational research”.

3.5 SUMMARY

The purpose of this investigation was to provide industry-specific information on internal NPD process issues and variables for European automotive component suppliers, the measures of success performance used, as well as to provide confirmation that previously used variables were appropriate for this industry (Douglas and Craig, 1983). This was undertaken using a rigorous qualitative research methodology.

By exploring in some detail the NPD development practices among the firms studied, several similarities and differences between the practices of this industry and those of previous investigations could be observed. Many previously used measures were corroborated by the findings of this study. Others were not. Many new measures were also identified, especially for the internal NPD process, which is unsurprising due to the focus of the study.

Only three types of innovation were uncovered by the interviews: ‘engineering applications’; ‘genuine NPD’; and ‘Blue Sky projects’. This is compared with the six independent categories identified in the literature. The suggestion from the interview findings is that different types of projects are not developed in the same way. Any future research in this area should, therefore, consider and identify the types of NPD projects they are collecting data on to ensure that research is comparable.

Success measures, while reasonably consistent with those recommended by Griffin and Page (1996), also included some other important performance criteria. Some of these had been used before in other previous studies, such as ‘window of opportunity on new markets and new products’, whereas others were completely new measures. Quality was seen as two separate measures, reject levels and warranty levels. How well the project stayed within budget costs was also noted as a measure of performance by the managers interviewed. Whilst this measure was identified in the
total list of measures of product development success and failure generated by Griffin and Page (1993), it was not the suggested as a core success/failure measure because it was not common to both researchers and practitioners. Other recommended measures (Griffin and Page, 1996) were not identified at all by the study, such as: break-even time and revenue growth goals. This suggests that there could well be sets of industry specific measures for performance, as suggested by the literature (Craig and Hart, 1992).

Consistent with some of the literature (Craig and Hart, 1992, Rochford 1991) but not many past empirical studies into characteristics of successful NPD, the source of the new product idea was identified as important to the final outcome of the development project.

In terms of items relating to the development process, previous studies only use thirteen very general measures to evaluate the development performance of firms undertaking NPD (Cooper, 1979a). The exploratory research identified 58 supplementary variables relating to the development process used by the firms interviewed. Many of these variables simply provide more in-depth items relating to the overall questions used in previous studies. However, the findings were not always consistent, for example, where some firms thought that this should be in the form of “broad wish lists at this stage” (Firms 2,7), others insisted that these should be well documented including “carefully defined specifications” (Firm 1).

Where measures have not been corroborated it is not, however, possible to suggest that these findings are conclusive. Indeed, the problems associated with such a small sample size of only ten interviews and the non-probabilistic nature of the sampling are constraints upon the generalisability of the findings. However, what is more important is the number of new variables/issues that have been identified during this study. Both the lack of substantiating evidence for some variables and the new variables identified clearly suggest that quantitative research needs to be conducted in order to confirm (or otherwise) the insights found from the exploratory interviews.

In the chapter that follows, the findings of the exploratory phase are used to supplement the literature to facilitate the development of a conceptual model of NPD process success and failure.
CHAPTER 4
CONCEPTUALISATION OF THE STUDY

This chapter develops the theoretical basis for the main empirical investigation. First a conceptual framework will be presented. This framework is based largely on a previous framework by Cooper and Kleinschmidt (1987c, 1993a) as well as on other insights provided by the literature (Chapter 2) and the exploratory research (Chapter 3). In the following section, the justification for the proposed conceptual framework is discussed. Next the model is described in detail, including justification for the hypotheses related to the proposed linkages of interest.

4.1 A MODEL OF NPD PROCESS PERFORMANCE

Previous research studies identified in the literature review (Chapter 2) describe a broad set of factors that have been found to discriminate between new product success and failure, such as, top management commitment, introducing a unique and superior product, or marketing synergy. However, these findings have tended to be very general and this has made it difficult for those involved in NPD to apply the lessons presented - “they are unable to relate them directly to their own situation” (Craig and Hart, 1992:38).

Cooper (1979a, 1979b) postulates that the success of new product development is determined by: 1) environmental factors, such as the corporate environment, and the market and competitive environment, which relate to the setting in which a new product is developed; and 2) controllable factors, which relate to the characteristics of new product activities that are controlled by firms, such as the proficiency of the new product development process and the characteristics of the commercialised product. These factors were integrated into a framework, developed by Cooper and Kleinschmidt (1987c, 1993a), which identifies the blocks of variables that were thought to impact on new product performance (see figure 2.5, Chapter 2).

Key to the modification of this study’s framework (see Figure 4.1 v Figure 2.5) is the suggestion that the ability to improve the success or failure of new products is under managers’ control (Calantone and di Benedetto, 1988). In a meta-analytic review of the literature, Montoya-Weiss and Calantone (1994) suggest that certain controllable
factors (strategic and development process factors) are most strongly associated with performance and that the manipulation of factors over which managers exert some level of control offer the greatest opportunity for improving the success rate of new products.

However, not enough is known about these internal process factors (Calantone et al., 1996). This is confirmed by the findings of the exploratory study which identified that the source of the new product idea and project organisation were separate constructs and thus, should be included in the model.

Therefore, for this study, the Cooper and Kleinschmidt (1987c, 1993a) framework has been adapted to highlight the internal/controllable project variables related to the organisation of the new product development team, the new product development process and the product itself, as well as the links between each of the constructs and ultimately, with success performance (Figure 4.1).

However, success is not determined from internal factors in isolation but also from interactions with the market environment (Calantone et al., 1997; Crawford 1986; Cooper and Kleinschmidt 1987b) and corporate/organisational factors (Calantone et al., 1996). These factors have not been well tested (Montoya-Weiss and Calantone, 1994), and they go on to suggest that the “lack of testing (or reporting) of many of the market environment and organizational factors” may well have contributed to the identified dominance of the internal factors (Montoya-Weiss and Calantone, 1994:412). Therefore, it is also necessary to collect information on the external environment variables, both corporate and market environment in order to examine the potential moderating effect of these variables to identify whether they are significant or not in determining new product success (Montoya-Weiss and Calantone, 1994; Song and Parry, 1996).

Another modification to the framework is the suggested linkage between the market environment and early stages of the development process. The Kleinschmidt and Cooper (1995) model seems to suggest that ‘Corporate Characteristics’ only affect the ‘front end’ of the actual development process and that ‘Market Characteristics’ only affect development further along the process, including the eventual outcome. The interviews, however, suggested that the market environment affects the whole process, from start to finish, through the source of new product idea, the strategy formulation,
as well as the eventual outcome (see section 3.3.4, Chapter 3). Equally, the Corporate Environment can also have an influence throughout the development process. Therefore, the new framework reflects this by showing linkages between the market environment and the source of the new product idea and new product strategy and between corporate characteristics and new product strategy, project organisation, and the new product process.

**Figure 4.1 - Conceptual Framework**

To summarise the above discussion about the conceptual framework, the proposed model postulates that the new product outcome (success or failure) is the result of the interactions between internal process variables, moderated by external company/environment antecedents/variables (Calantone et al., 1997; Montoya-Weiss and Calantone, 1994; Song and Parry, 1996).

This work aims to validate these internal project characteristics as they relate to each of the performance outcomes as well as including the direct impact of the market environment. In the following sections, the elements of the model are described, including a set of detailed hypotheses which have been generated relating to specific linkages within the proposed framework. The linkages were formulated after analysing the NPD literature (Chapter 2) and the findings of the exploratory study (Chapter 3) to identify important research issues and areas of weakness in the past research, such as, the importance of identifying success dimensions prior to analysis and the lack of implementation by practitioners.
Only factors related directly to performance will be tested during the operationalisation of the study. The reasons for including the variables with an indirect impact on performance in the model, and their justification will be presented first. Then, the variables which are suggested to have a direct link to performance will be discussed, including the specific hypotheses to be tested.

4.1.1 PROJECT ORGANISATION

This section refers to the impact that the organisation of those involved in the project has on new product success (Larson and Gobeli, 1988; Maidique and Zirger, 1984; Rothwell, 1972). Cross-functional integration has been identified as an important determinant of new product success (e.g. Griffin and Hauser, 1992, 1993; Song and Parry, 1996). This was also found to be true for the firms studied in the qualitative research. One of the findings of Project SAPPHO was that the effectiveness of internal and external communication was one of five factors that distinguished between successful and unsuccessful new products (Rothwell et al., 1974; Rubenstein et al., 1976). This has been confirmed by Maidique and Zirger (1984: 201) who conclude that the probability of new product success rises when “the create, make, and market functions are well interfaced and co-ordinated”. Several studies that have focused specifically on the R&D-marketing interface have found that the integration of R&D and marketing is explicitly linked with new product success (e.g. Song and Parry, 1993).

The presence of a formal new product process or stage-and-gate system is also positively related to success (Cooper and Kleinschmidt, 1991, 1993c).

Top management support is another proposed success determinant (Booz et al., 1982; Larson and Gobeli, 1989) and was significantly correlated with 5 measures of new product success, although “the correlation’s coefficients themselves tended to be low” (Cooper and Kleinschmidt, 1987b:180). The exploratory study suggested that project organisation factors were not directly linked with success, but that these variables did affect the development process.

Thus, project organisation is suggested to be positively related to success via the development process.
4.1.2 NEW PRODUCT IDEA SOURCE

The source of the new product idea is important to the successful outcome of a development project (Montoya-Weiss and Calantone, 1994; Rochford, 1991; Von Hippel, 1986; Myers and Marquis, 1969). The findings of the exploratory study (see section 3.3.4, Chapter 3) identify that the sources can be both internal and external to the organisation, which agrees with past literature (Calantone and Cooper, 1981; Mathot, 1982). They can also be thought of as driven by market or technology (Cooper, 1983), however the Cooper (1979b:102) study found that both successful and failed products were largely market-derived and that "whether a product is market-derived or not - the source of the idea - simply does not differentiate all that well between success and failure".

Obviously there is little agreement on the affect that the source of the new product idea has on success performance. However, the findings of the exploratory study suggest that this antecedent is linked to both project organisation and the development process activities.

4.1.3 CORPORATE CHARACTERISTICS

Building on one’s in-house strengths has been found to be a key to successful new product development (Cooper, 1979a, 1979b, 1980; Cooper and de Brentani, 1984; Cooper and Kleinschmidt, 1987b, 1987c, 1988, 1990; de Brentani, 1991; Link, 1987; Maidique and Zirger, 1984; Peters and Waterman, 1982). These include: 1) marketing synergy, which represents the fit between the needs of the project and the firm’s salesforce, distribution, advertising, promotion, market research and customer service resources and skills. However, only variables related to market research, and distribution were found to be applicable to the automotive components industry (see section 3.3.1, Chapter 3). 2) technological synergy, which represents the fit between the needs of the project and the firm’s R&D, engineering and production resources and skills (Montoya-Weiss and Calantone, 1994). These were all identified as important for the industry under investigation (see section 3.3.1, Chapter 3).

Cooper (1979a) reports a significant positive correlation between new product success and a) the level of the firm’s marketing resources and skills, and b) technical resources and skills. In a discriminant analysis of the same data, Cooper (1979b:101) finds that the second and third most important discriminators of new product success and failure
were a "marketing knowledge and marketing proficiency" factor and a "technical and production synergy and proficiency" factor. These results were confirmed in later studies using multiple measures of success (Song and Parry, 1996). Montoya-Weiss and Calantone (1994) also identify the characteristics of the corporate environment that contribute to new product success: 1) the level of marketing synergy, which refers to a project's fit with a firm's existing marketing skills and resources; and 2) the level of technical synergy, which refers to a project's fit with firm's technical skills and resources. Past research suggests that firms must possess adequate resources and skills in both marketing and technical activities for successful new product development (Cooper, 1976; Cooper and Kleinschmidt, 1987b, Song and Parry, 1996). However, this necessary condition does not guarantee NPD proficiency.

Organisational factors are hypothesised to be associated with new product success only indirectly through proficiency of NPD activities and product strategy (Calantone et al., 1993). The mere existence of resources and skills should not directly affect the degree of new product success (Day and Wensley, 1988, Calantone et al., 1996). The exploratory study also identified that these factors also affected performance through project organisation. The level of resources and skills available was identified to affect the ability of the project team to function properly. Those firms with larger resources could afford to have dedicated teams for each individual project whereas those firms with fewer resources had individuals attached to more than one project team at any one time, creating potential conflicts.

4.2 FACTORS INFLUENCING NPD PERFORMANCE

4.2.1 SUCCESS PERFORMANCE MEASURES

Key to understanding the issues related to success and failure of new products is being able to measure 'success' and 'failure'. There is very little consensus in past literature over how best to operationalise "success" (Hart 1993) and there has been much debate about the appropriateness of particular measures, and about the best way to combine 'financial' and 'non-financial' measures (Hart, 1993; Griffin and Page, 1993, 1996). This use of different success/failure measures has made it difficult to draw generalisations across investigations (Griffin and Page, 1993). Cooper even suggests that "a preoccupation with financial results and financial gauges of success may have had some detrimental effects on the field of product innovation." (1987c: 215).
An important issue identified during this look at how success and failure is defined is that studies have found more than one dimension of success (Cooper, 1987b; Hart, 1993, Griffin and Page, 1993; Hultink and Robben, 1995). Such research has identified three dimensions of NPD performance, including: financial; consumer/market-based and product/technical-based performance. A fourth dimension that has also been identified is ‘window of opportunity’ success (Cooper and Kleinschmidt, 1987c; Song and Parry, 1996).

The logical extension to this multi-faceted portrayal of success is that different factors may lead to different types of success and “if research is to throw light on new product success, for the benefit of both the academic and business community, it must clearly show what types of product development strategies and processes will result in what type of success” (Hart, 1993:35). This is backed up by Cooper (1987c:217) who states that, “Since there are different dimensions of success, then conceivably, there could be three independent sets of success factors”. This is particularly likely due to the fact that success on one dimension may be achieved at the expense of performance on another dimension (Cooper, 1984; Hultink et al., 1997; Hart, 1998).

Multiple dimensions have been found to exist in a number of settings and understanding these dimensions is fundamental to uncovering reasons for practitioners under-utilisation of models (Mahajan and Wind, 1992). This is especially important in today’s dynamic market situations which have always been recommended for avoidance (e.g. Cooper, 1980). Therefore, it is important to identify whether these same four dimensions exist for the industry under investigation and to determine whether the critical success factors (c.s.f.) are different for each of these dimensions. This will ensure that the practitioners will be able to utilise the results for specific development situations rather than the previously provided generic findings which may or may not have been suitable for the type of success desired. Thus, the following hypotheses are proposed:

Hypothesis 1a: There are four dimensions of success for the Automotive Component Supplier Industry

Hypothesis 1b: The importance attached to the critical success factors (c.s.f.) differs depending on the dimension of success.
Therefore, whilst the linkages presented and justified in the next three sections (4.2.2 to 4.2.5) are known to affect overall success performance, what is unclear is whether the c.s.f. for each of the success performance dimensions are the same for all dimensions of success or whether they are different for each. The following model shows the direct linkages of interest using one performance dimension, financial success, as an example.

**Figure 4.2 - Antecedents of New Product Performance**

![Diagram showing internal project variables leading to financial success](image)

### 4.2.2 NEW PRODUCT PROCESS

Many of the development process activities have been cited as important determinants of new product success at the project level (Booz et al., 1982; Cooper, 1979a, 1979b, 1980, 1990; Cooper and Kleinschmidt, 1987a, 1987c, 1988, 1991; Crawford, 1984; Parry and Song, 1994; Song and Parry, 1996; de Brentani, 1991; Maidique and Zirger, 1984; Rothwell, 1972). Whether these NPD process activities are done, and their quality of execution, have been found to affect NPD outcome (Cooper, 1979a, 1979b, Cooper and Kleinschmidt, 1987a, 1993a, 1993b). A study by Cooper and Kleinschmidt (1995:334) identifies that “The new product process is very much in trouble, plagued by errors, omissions and doubtful quality of execution. The time is ripe to look at one’s innovation process: dissect it to uncover the root causes of these quality deficiencies; then re-engineer the process building in quality-of-execution and a strong market orientation; ...".
The literature identifies that Development Process Factors include: protocol; proficiency of pre-development activities; proficiency of market-related activities; proficiency of technological activities; top management support, control, and skill; speed to market; costs; and financial/business analysis (Montoya-Weiss and Calantone, 1994). The exploratory study found four development process stages consisting of activities which relate to: pre-development and product definition; design/development; testing and validation; and market launch (see section 3.3.4, Chapter 3). Thus, the following hypotheses are suggested:

**Hypothesis 2a-d:** The quality of the activities undertaken in each development process stages are positively related to new product success

### 4.2.3 NEW PRODUCT STRATEGY

*Product Advantage* and its elements, including: the presence of unique features; relatively high product quality; the ability to reduce customer costs and enabling the customer to perform a unique task, has been found to have a significant positive relationship with new product success in numerous previous studies (Cooper, 1979a; Cooper and Kleinschmidt, 1987a, 1987c; Maidique and Zirger, 1984; Song and Parry, 1996). Product Advantage refers to the customer’s perception of product superiority with respect to quality, cost-benefit-ratio, or function relative to competitors (Montoya-Weiss and Calantone, 1994).

*Non-product advantage* is the attainment of competitive advantage via salesforce, service and technical support, company image or reputation, brand name, and the perceived level of technical competence. “In increasingly competitive markets with relatively homogeneous products, management must often look to other elements of the market mix, outside product advantage, in order to gain competitive advantage and success” Cooper and Kleinschmidt, 1995:325). The impact of non-product advantage has not been extensively investigated for new products (Cooper and Kleinschmidt, 1993b; Kleinschmidt and Cooper, 1995). However, the findings of Cooper and Kleinschmidt’s (1993b) study did find that technical support and customer service and perceived technical competence of the firm were positively related to success.

The exploratory research identified that both product advantage and non-product advantage are affected by corporate characteristics and the market environment, and in
turn affect the new product process. However, as has been noted by previous studies, while adequate resources and proficiency in conducting new product activities are all important, the product must have some advantage relative to competitors offerings in order to be successful (Cooper and Kleinschmidt, 1987a, Calantone and di Benedetto, 1988; Song and Parry, 1996). Thus it is hypothesised that:

**Hypothesis 3a: Product advantage is positively related to new product success**

**Hypothesis 3b: Non-product advantage is positively related to new product success**

### 4.2.4 EXTERNAL ENVIRONMENT

Little attention has been paid to the influence of market context factors on project success (Brown and Eisenhardt, 1995) or on the influence of market context factors on the key drivers of project performance.

Cooper (1979a: 127) identified that environmental variables “do not play a critical role in deciding new product success”. Of 41 environmental variables only fifteen were significant and only eight strongly related. These findings are contrasted with the very strong ties that have been found between controllable variables and project outcome (Cooper, 1979a; Cooper and de Brentani, 1990; Calantone et al, 1996).

Two market environment factors that influence new product success have been examined: market potential and marketing competitiveness (Calantone and di Benedetto, 1988; Cooper, 1979a, 1979b; Cooper and Kleinschmidt, 1987b, 1993b; Parry and Song, 1994; Zirger and Maidique, 1990). Market Potential is a measure of market (and demand) size and growth. It also provides an indication of customer need level for the product type and the importance of the product to the customer. Market Competitiveness reflects the intensity of competition in the marketplace in general and/or with respect to price, quality, service, or the salesforce/distribution system (Montoya-Weiss and Calantone, 1994). The first was significantly correlated with seven of the eleven success measures (See also Cooper, 1979a, 1979b). The second was not significantly correlated with any of the 11 success measures (see also Calantone and di Benedetto, 1988; Cooper, 1979a; Cooper and Kleinschmidt, 1993b). Other studies have found a negative relationship between the level of market competitiveness and new product success (Cooper, 1975; Zirger and Maidique, 1990; Parry and Song, 1994).
These factors have not been well tested and it is assumed that the lack of reporting of environmental factors must be due to the fact that they were found to be insignificant (Montoya-Weiss and Calantone, 1994). However, Montoya-Weiss and Calantone (1994) go on to note that some of the individual environmental variables did appear to have some influence on the new product outcome, including: degree of customer need for products in this class, rate of growth of market; degree of customer satisfaction with competitive products; and synergy or compatibility of the resource base. A few studies have attempted to distinguish the direct and indirect relationships among environmental variables, measures of new product development proficiency and new product success (Calantone and di Benedetto, 1988, 1990; Zirger and Maidique, 1990; Parry and Song, 1994; Song and Parry, 1996; Mishra et al, 1996). Zirger and Maidique (1990:878) report that “failures were more likely for products introduced into highly competitive markets”. Parry and Song (1994) and Song and Parry (1994) found strong negative correlations between measures of competitive intensity and new product success in both China and Japan. A study by Mishra et al (1996) revealed the intricate relationship of environmental and controllable factors to the NPD process in Korea and they go on to suggest that further focused research is needed to better understand the relationships between factors.

Obviously, there are contradictory findings as to the impact of the external market on the eventual project outcome. More research is required to understand the contextual nature of environmental factors in order to improve the explanatory power (Montoya-Weiss and Calantone, 1994). Therefore, it is also necessary to investigate the nature of the interactions between the internal process variables and environmental factors.

This study will concentrate on examining the direct effect of the market environment on new product performance. Therefore, the following two hypotheses are suggested:

**Hypothesis 4a:** The level of new product success is positively related to a high level of market potential

**Hypothesis 4b:** The level of new product success is negatively related to the level of competition in the market
4.3 SUMMARY

This chapter introduced the conceptual background for the study by developing a model of the constructs that are hypothesised to affect, both directly and indirectly, new product performance.

By developing theoretically-driven hypotheses the study can go beyond a purely descriptive investigation. This is consistent with the study’s research objective and its intended contribution (see Chapter 1, section 1.3). To achieve these objectives against the theoretical background developed in this chapter it is necessary to collect empirical data. The next chapter describes the procedures used for data collection.
CHAPTER 5
METHODOLOGY

This chapter provides a detailed description of the methodology used for the quantitative stage of the research, including the data collection method and forms, the sampling frame and data collection procedures followed.

Most of the items that can be identified from the literature were developed for studies conducted in the U.S. or Canada, shown by the apparent geographic bias of studies undertaken in Canada (Montoya-Weiss and Calantone, 1994). Douglas and Craig (1983) identify a danger in using a construct or measure previously developed in one cultural or industry setting and assuming that it will work in a different cultural or industry setting. They have emphasised the importance of establishing the "comparability" of data collected in different cultural contexts, known as construct validity, as well as the same level of accuracy, measurement precision, and/or reliability across countries and cultures.

5.1 PREVIOUS METHODOLOGIES

Common designs should have developed to provide a replicative, integrated scientific approach for advancing the field. However, this has not been the case. What is found is a wide variation in research designs, methods and operationalisations of the dependent and explanatory variables used to study new product performance (Montoya-Weiss & Calantone, 1994).

Research methodologies vary between quantitative and qualitative; the level at which researcher focus their attention varies between the "programme" and "project" levels; the way success is measured is not consistent; and the type of new product developments which are investigated vary from 'new to the world' to 'modifications' (Craig & Hart 1992). These differences have been exacerbated by the fact that these variables are not well-reported (Montoya-Weiss & Calantone, 1994).

Much past and current research remains exploratory in nature, focused on the identification rather than explanation of factors (Cooper & Kleinschmidt, 1987b). This persistent exploratory nature of the empirical New Product Development
research is due to the lack of organised synthesis of past research (Montoya-Weiss & Calantone, 1994).

However, despite the variation in data sets, methodologies and operationalisations the results are remarkably consistent. So, why are products still failing at an alarming rate? Craig and Hart (1992) suggest that this could be explained by the fact that researchers are clearly influenced by previous studies from which they derive the variables for measurement perhaps to the exclusion of other important factors. As a consequence, very similar variables are examined leading to a series of highly intercorrelated results.

A study by Link (1987), using open-ended questions to ask respondents to cite any additional critical success factors, unearthed three new factors which had not previously been identified. This gives weight to a concern that findings are similar because of 'averaging' of results, both across industries and across different types of new product development strategies (Cooper and Kleinschmidt, 1993b).

Song & Parry (1996) in their study of Japanese new product winners and losers attempted to address these issues by developing a research instrument that was appropriate in the Japanese context to ensure that they were using valid and reliable measures using the research design process proposed by Douglas and Craig (1983).

Montoya-Weiss and Calantone (1994) suggest that the nature of statistical inference and deduction has improved over time with empiricism evolving from:

1. descriptive statistics (including means, frequencies and proportions)
2. tests of differences/similarities (including t-test, binomial test, ANOVA and MANOVA)
3. measures of dimensionality (including factor analysis, cluster analysis, and discriminant analysis)
4. interpretation of parameters statistically (including correlation analysis, canonical correlation analysis, regression analysis, path analysis and structural equation models)

However, the average dates of articles published for each type of empirical research process suggest that the research is not steadily progressing along an ever more quantitatively sophisticated path (Montoya-Weiss & Calantone, 1994).
Unfortunately, simple first level designs employing descriptive statistics including means, frequencies and proportions are still common in new work. These issues must be addressed if future research is to progress to provide greater explanation of factors. There is also a need to move away from the idea that there is one simple answer to how companies can achieve success in developing new products (Craig and Hart, 1992) and to adopt a contingency approach instead, which "emphasises the importance of situational influences on the management of organizations and questions the existence of a single, best way to manage or organize" (Zeithaml et al., 1988: 37).

5.2 UNIT OF ANALYSIS

The project level was used as the level of analysis. This approach has recently been criticised because there may be company practices that are not apparent at the project level that are important to success and success at the company level may well be different than at the project level (Cooper and Kleinschmidt, 1995). However, the focus of this study is the internal development process activities and the rationale is that the activities and performance vary across new products within the same firm. Therefore, it is argued that product analysis provides more reliable data than firm level analysis (Atuahene-Gima 1995, Cavusgil & Kirpolani, 1993). The unit of analysis will be a major system/sub-assembly development project by an automotive component supplier, as defined by Lamming (1993). For the purposes of this thesis the definition of new products is restricted to new models of an established product in a market in which the firm already competes (Clark et al, 1987). These must be significant projects (not just extensions or reformulations which were introduced within the last five years (Cooper and Kleinschmidt, 1993a). Therefore, this definition will avoid any engineering applications of an existing product to a new model, which do not often pass through a full development cycle. It will also avoid completely new products to the company, because these often involve atypical development practices over longer time scales (Chapter 3, section 3.3.2.). This will ensure that the innovativeness of projects on which data is collected will be comparable.

These development projects must have been launched during the last five years, as suggested by previous research studies. The use of a five year retrospective can create
problems related to temporal stability (Montoya-Weiss and Calantine, 1994) and construct validity, due to changes in the environment, changes in strategy, recall problems and survivor bias (Cooper, 1992; Crawford, 1986). However, development projects in the Automotive Industry generally take up to three or four years. Therefore, five years was thought to provide a sufficient time period for them to identify two development projects (one success, one failure) that fit the unit of analysis criteria.

It was also identified during the exploratory research that the five year time scale was appropriate and that respondents who had been part of the development teams up to five years ago would be readily available. The respondents ability to recall this information correctly is discussed in section 5.5.3.

5.3 DATA COLLECTION

In deciding on a data collection method “the primary consideration is which technique is capable of generating appropriate information from the appropriate sample at the lowest cost (Tull and Hawkins, 1993:181, emphasis in the original). For this study, secondary data was not available and observational methods were not thought practical due to time, access and cost considerations. Another approach considered was to perform a longitudinal study tracking new products throughout their development from idea through to post-launch success or failure. The benefits of longitudinal analysis is in it’s ability to detect changes as a result of repeated measurement of the same variable on the same sample (Churchill, 1995). Relatively large amounts of data can be collected and are usually more accurate (Malhotra, 1996). However, due to the length of automotive development projects, time constraints precluded the use of this method and longitudinal techniques are not without problems (Churchill, 1995). True longitudinal studies can only be performed with the same entities with replication over time. Panel members require compensation for their participation because of the amount of time required to conduct several interviews. Therefore, respondents may not be representative because of mortality and payment, which may cause the wrong people to participate (Malhotra, 1996). There could also be response bias, both in the initial responses because they want to give what they think are the “right” answers, and later because
the interviewees believe that they are experts (Malhotra, 1996). Responses may also deteriorate due to boredom (Malhotra, 1996). Consequently, a questionnaire design was chosen which would be used to collect data on both a successful and a failed new product development from each responding firm.

The next section documents the procedures followed to develop the research instrument and a discussion of pretesting procedures. After this the main survey implementation is discussed. Finally, an analysis of the responses is presented.

5.4 SAMPLE

The sampling population is defined as all automotive component suppliers in the U.K. undertaking 'significant' NPD projects (as defined in section 5.2). The sampling frame is the listing of the elements from which the actual sample will be drawn (Churchill, 1995). For this study the Society of Motor Manufacturers and Traders (SMMT) 1997 database of members was chosen as the sampling frame, as it was suggested by industry experts to be the most complete listing of UK automotive component suppliers available. However, there is "rarely a perfect correspondence between the sampling frame and the target population of interest" (Churchill, 1995:577). The requirement is to develop an appropriate sampling frame when the list of the population elements is not readily available. Frame error can occur due to the fact that the mailing lists are not likely to provide complete coverage of the target population. The exploratory interviews all indicated that the project manager was the most appropriate informant, which was also found to be true by Song and Parry (1996) and Larson and Gobeli (1989). However, a potential source of error identified was the fact that these contact names were not necessarily the relevant respondent to be sampled. However, the exploratory research suggested that these contacts were able to identify the most appropriate person and their position in the organisation was such that they had sufficient authority to delegate this task to the appropriate person.

The SMMT database was comprised of 907 firm records. However, after the first pilot it was discovered that the database also included firms who were not undertaking NPD, as well as many records which were out of date in terms of contact names, firm names and addresses. Therefore, telephone calls were made in order to improve the database, the details of which will be discussed in section 5.6.3. After the telephone calls the sampling frame was reduced to 350 firm records. It was decided that a
census of all the identified companies would be carried out in order to obtain enough responses.

5.5 QUESTIONNAIRE DESIGN

"The preparation of a good questionnaire requires time and thought. The questionnaire must serve its goal of providing reliable and valid data in a usable form which meets the needs of the researcher" (Cragg, 1991: 182). The literature suggests several steps to be considered when designing a questionnaire, however "in practice the steps were highly interrelated, and the decisions made during one step will often influence alternatives at another step" (Luck & Rubin, 1987:174). Furthermore, repeated iterations of the various stages are often necessary (Churchill, 1995). The procedure suggested by Churchill (1995) for developing a questionnaire was utilised in the present study (Figure 5.1). Similar approaches are advocated by other authors in the methodological literature, for example, Oppenheim (1992), Aaker et al., (1995), and Malhotra (1996).

Figure 5.1 - Procedure for Developing a Questionnaire

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Specify What Information Will Be Sought</td>
</tr>
<tr>
<td>2</td>
<td>Determine Type of Questionnaire and Method of Administration</td>
</tr>
<tr>
<td>3</td>
<td>Determine Content of Individual Questions</td>
</tr>
<tr>
<td>4</td>
<td>Determine Form of Response to Each Question</td>
</tr>
<tr>
<td>5</td>
<td>Determine Wording of Each Question</td>
</tr>
<tr>
<td>6</td>
<td>Determine Sequence of Questions</td>
</tr>
<tr>
<td>7</td>
<td>Determine Physical Characteristics of Questionnaire</td>
</tr>
<tr>
<td>8</td>
<td>Re-examine Steps 1-7 and Revise if Necessary</td>
</tr>
<tr>
<td>9</td>
<td>Pretest Questionnaire and Revise if Necessary</td>
</tr>
</tbody>
</table>

5.5.1 INFORMATION SOUGHT

It is important to specify exactly what information is to be collected from each respondent, as a lack of relevant information or incomplete information can affect the results (Aaker et al., 1995). Therefore, the researcher needs to ask "how will this information be used?" (Aaker et al., 1995:292).

The research objectives (see Chapter 1, section 1.3) and the conceptual framework of the NPD process and performance (Figure 4.1, Chapter 4) determined the information required. Table 5.1 provides a list of the broad issues to be included in the measurement instrument.

Table 5.1 - Issues to be included in measurement instrument

<table>
<thead>
<tr>
<th>Scale Constructs</th>
<th>Information Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Strategy</td>
<td>a) Product advantage: uniqueness, performance, quality and cost</td>
</tr>
<tr>
<td></td>
<td>b) Non-product advantage: Technical competence; company reputation/brand; product availability/delivery</td>
</tr>
<tr>
<td>Project Organisation</td>
<td>Team composition, communication</td>
</tr>
<tr>
<td>New Product Process</td>
<td>a) Pre-development Assessment: marketing and technical assessment, concept generation and evaluation, and project planning</td>
</tr>
<tr>
<td></td>
<td>b) Development: process by which the product and process is developed</td>
</tr>
<tr>
<td></td>
<td>c) Testing/Validation: the testing and validation of the product and the process</td>
</tr>
<tr>
<td></td>
<td>d) Market Launch: meeting delivery, quality, and legislative requirements</td>
</tr>
<tr>
<td>Corporate Characteristics</td>
<td>Financial, marketing and technical resources</td>
</tr>
<tr>
<td>Market Environment</td>
<td>a) Market potential: market size, growth and customers need</td>
</tr>
<tr>
<td></td>
<td>b) Market competitiveness: price/non-price competition; loyalty and satisfaction, number and strength of competitors, similarity of products, and barriers to entry</td>
</tr>
<tr>
<td>Other Measures</td>
<td></td>
</tr>
<tr>
<td>Source of Idea</td>
<td>Whether the source is internal or external</td>
</tr>
<tr>
<td>Background Information</td>
<td>Classification variables including: type of product; duration of the development; number of employees; turnover; spending on R&amp;D; job function and management level</td>
</tr>
</tbody>
</table>

1. Note that all issues to be covered in the questionnaire relate to 'significant' NPD projects only, for reasons discussed in section 5.2.
5.5.2 TYPE OF QUESTIONNAIRE AND METHOD OF ADMINISTRATION

It is important to ensure that the type of questionnaire and the method chosen to administer the study is appropriate (Churchill, 1995). First, the researcher needs to make decisions about the structure and disguise of the questionnaire. Structure is the degree of standardisation imposed on the questionnaire. Disguise is the amount of knowledge about the purpose of a study communicated to a respondent (Churchill, 1995). These two issues are highly interrelated (Churchill, 1995). For this study a structured, undisguised questionnaire was chosen, which is the most common type of design used in market research (Churchill, 1995). Questions are presented with exactly the same wording, and in exactly the same order, to all respondents. This makes them simple to administer and easy to tabulate and analyse (Churchill, 1995; Selltiz et al., 1976).

Questionnaires are also classified by the method used to administer them. Churchill identifies three main methods, which are: 1) personal interview, which implies a direct, face-to-face conversation between the interviewer and the interviewee; 2) telephone interview, where the conversation takes place over the telephone; and 3) the mail questionnaire, which involves posting a questionnaire to respondents who then complete and return it in their own time (Churchill, 1995).

Oppenheim (1992) suggests that standardised interviews (i.e. first two listed above), generally yield higher response rates. This is because the interviewer can persuade the person to supply answers (Luck and Rubin, 1987). They are useful if numerous open-ended questions are asked, or if the questionnaire is complex because the interviewer can explain and clarify difficult questions (Malhotra, 1996). Personal interviews can also give a better explanation of the study than a covering letter for a mail questionnaire. However, they are more expensive, especially when respondents are spread over long distances and their administration can introduce bias into the study (Oppenheim 1992; Churchill, 1995; Malhotra, 1996). Interviewer bias can come from the manner in which he/she: 1) selects respondents; 2) asks research questions, e.g. by omitting questions, or from mannerisms and inflections (Luck and Rubin, 1987); and 3) records answers, which can be either incorrect or incomplete.
Nor do they provide the same level of anonymity which can be very important in gaining responses (Luck and Rubin, 1987).

In keeping with the majority of new product success studies (Cooper, 1979a, 1979b; Cooper and Kleinschmidt, 1987a; Parry and Song, 1994; Song and Parry, 1996; Calantone et al., 1988, 1996), data on each project was collected via a detailed, structured, self-completion questionnaire.

The respondents were widely dispersed and therefore, the cost of carrying out personal interviews would have been unacceptable. Telephone interviews would have been expensive, given the length of the research instrument. Also, the exploratory interviews had shown that the NPD managers were very busy and often difficult to contact by telephone. It would also have been too difficult to administer over the telephone because of the complexity of the questionnaire (Churchill, 1995).

The advantages of using mail questionnaires are that they are rapid, anonymous, limit surrogate information error, have the greatest versatility, avoid interviewer bias and are relatively inexpensive (Churchill, 1995; Aaker et al., 1995). They allow the respondent to take as much time as is required to answer the questions, in case they need to look up information or consult others (Churchill, 1995). However, they often produce low response rates which as a consequence can produce bias (Aaker et al., 1995; Churchill, 1995; Luck and Rubin, 1987; Malhotra, 1996). Also, there is no means of checking on incomplete responses and no opportunity to correct misunderstandings, nor do they provide data of any qualitative depth. They can also suffer from sequence bias as respondents can view the entire questionnaire as they respond (Churchill, 1995; Malhotra, 1996; Aaker et al., 1995). Nevertheless, mail surveys are effective in industrial marketing research (Aaker et al., 1995).

In consideration of sample size requirements across the UK, a postal survey was the only feasible method of data collection. This approach was thought to be least intrusive, allowing anonymity important to managers of failed projects.

5.5.3 INDIVIDUAL QUESTION CONTENT/QUESTIONNAIRE ITEMS

In terms of questionnaire items, several questions have to be asked: 1) is the question necessary; 2) are several questions necessary instead of one; 3) do respondents have necessary information; and 4) will respondents provide the necessary information
(Churchill, 1995, Luck & Rubin, 1987; Malhotra, 1996). These points must be kept in mind when deciding upon the content of individual questions.

The third question is particularly important in that one needs to ascertain whether respondents are informed enough to answer, whether they can remember the information required, and whether they can articulate this information (Malhotra, 1996). For questions dealing with the past, serious attention must be paid to the respondents' ability to recall the required information accurately; and to ways in which they can be helped to do so (Churchill, 1995), without introducing bias (Malhotra, 1996). Crawford (1979) criticises surveys as a method for obtaining data on New Product Development projects, suggesting that asking company personnel to recall sets of new products over a five year period is too memory intensive, subjective and may vary between functions such as marketing and R&D. Further, potential problems exist when using single key informants (Phillips, 1981). However, Brown et al (1984) note that the use of single informants is valid when the respondents possess unique process insights, and, while variables measured retrospectively may product key informant after-the-fact rationalisation, objectively worded scales are common in this type of work and are thought to limit post-hoc bias (Cooper and Kleinschmidt, 1994). Postal surveys also give respondents as much time as is required to answer the questions, in case they need to look up information or consult others which can help with recall error (Aaker et al., 1995; Churchill, 1995). It was also confirmed in the exploratory study that the respondents would be able to remember project information and would be able to refer back to document evidence or consult with other members of the team to aid recall.

Beginning with the Cooper ‘NewProd’ 77 variable set (Cooper 1979a and b), which have been well-validated, the questionnaire also included new variables developed from the exploratory interviews and other important literature in order to focus on the internal development process in more detail. These include: Song and Parry, 1994; Parry and Song, 1994; Calantone and Cooper, 1981; Kleinschmidt and Cooper, 1995; Zirger and Maidique, 1990; and Maidique and Zirger, 1984. Some other questions identified by experience surveys as not being important for this industry were also removed.
Eleven of the twelve constructs (including project outcome) identified in chapter 4 were operationalised by a summated rating scale, using scale development techniques which will be discussed in the next section. The source of the new product idea was not measured using multiple items. Appendix 5.1 reports the items used to measure each of the constructs, the response format employed in the questionnaire, and selected sources for each item. Each section is discussed in greater detail below.

**SECTION 1: PRODUCT STRATEGY**

Section 1 of the questionnaire has 18 questions, 15 of which are primarily concerned with issues of product advantage and non-product advantage (as defined in chapter 4, section 4.2.3). The first eleven items relate to the products' perceived superiority relative to competitors products. These items are drawn from Cooper (1979a); Song and Parry (1996, 1997); Kleinschmidt and Cooper (1995) and Zirger and Maidique (1990), and have been used in many previous studies to assess the product's relative performance, quality, cost and value, as well as the presence of unique features or attributes. The four non-product advantage items assess the attainment of competitive advantage via technical competence, company reputation or brand name, product availability and flexibility of production.

This section also includes three introductory questions. The first relates to whether the product was deemed a success or failure. This is important for focusing the respondent on the particular project and for providing a dichotomous measure for success and failure. The other two relate to the product type and the project duration. These are important because, generalisation of the findings of previous studies may be limited because of systematic differences in the data collected, as suggested by Mishra et al. (1996). Therefore, information on these two variables has been collected in order to test for any differences due to these factors.

**SECTION 2: PRODUCT DEVELOPMENT**

This section looks at how the product was developed, including organisation and process activities involved in developing a product from an initial idea through to its market launch. It is divided into six sub-sections which are described below.
**Project Organisation**

Project organisation can be divided into two issues: cross-functional integration and internal commitment (Song and Parry, 1997). Cross-functional integration is defined as “the process of achieving effective unity of efforts in the accomplishment of new product development success” (Song and Parry, 1997). The degree of integration refers to the level of involvement and communication between all members of the development team. These members also include external partners such as customers or suppliers. Internal commitment refers to the existence of individuals who were dedicated to the success of the project. This construct has two items that assess top management support and the existence of a project champion/leader (Rothwell, 1977, Maidique and Zirger, 1984, Larson and Gobeli, 1988, Song and Parry, 1997).

Added to these items from previous literature are four new items based on the exploratory findings. These new items are: whether the project manager had sufficient authority; whether the cost of the project was closely monitored; whether the process was highly formalised; and whether the project had been developed as a joint venture with customers, suppliers, or competitors.

**Source of New Product Idea**

The source of the new product idea was identified during the exploratory research as an important driver of new product success. These sources can be internal to the company or external, such as: Customers, Suppliers, Competitors, or even other industries, academic institutions or, in this industry, legislation, as identified by the exploratory interviews (Chapter 3, section 3.3.4).

**Pre-Development Activities**

Market assessment was evaluated with eight items that address the firm’s understanding of the potential market for the new product and their evaluation of potential customers and competitors. These items assess the firms knowledge of market size, customer needs, price sensitivities as well as competitors products, what they are and when they are due to be launched (Song and Parry, 1996).

Technical assessment refers to the firms technological information, i.e. “the firms understanding of a product’s technical requirements” (Song and Parry, 1996:427). Eight items address the technology, cost and likely technical problems, as well as their
ability to develop a product with the desired specification/features. Two of the items
used were identified from the exploratory literature. These refer to the firms ability to
assess sourcing alternatives and environmental issues.

Concept generation and evaluation refers to how comprehensively the product concept
was developed and evaluated. This construct has six items which relate to the
generation of a comprehensive product concept, whether it was translated into
business terms, and how well the screening was undertaken (Song and Parry, 1996).

The questionnaire also includes three items that address the project planning process.
These plans include producing detailed timetables for subsequent development stages,
defining team member responsibilities and establishing milestones against which
performance could be evaluated (Song and Parry, 1996).

Development Process

Previous studies have tended to use a single item for this construct, whether firms
‘undertook product development well’ (e.g. Cooper, 1979a, 1979b; Calantone et al,
1996; Mishra et al, 1996), which has been correlated with new product success.
However, a study by Kleinschmidt and Cooper (1995) which asked managers to rate
how well ‘product development (the actual technical development of the product)’
was undertaken and how important they felt this activity was, found that, whilst the
managers thought this activity was very important to success, the actual impact on
financial performance was relatively low.

Song and Parry (1996) group all the technical activities together regardless of which
stage of the process they refer to. However, the exploratory interviews identified that
the development process was more than just a technical activity and was undertaken
by more than just technical people. For this study the development process was also
found to include parallel processing activities including: the involvement of
manufacturing, development of the manufacturing process in parallel with the
product; production sourcing decisions; test/validation planning; and tooling
decisions.
Testing/Validation
The process by which the product and process was tested and validated was evaluated with six product items and four process items. The product testing and validation items refer to whether the firm: evaluated laboratory test to determine performance against specifications; interpreted the findings from the in-house trials; carried out extensive component bench testing and in-vehicle testing. They also address whether customers were involved with the product testing or whether it was outsourced altogether.

The four process items refer to how well the firm validated production, how well they carried out employee training, whether they attempted to optimise their production process, and whether the development process required several iterations before beginning full scale production.

Market Launch
As identified in the exploratory research (Chapter 3, section 3.3.4), the items used to assess market launch are different in the Automotive Industry. As identified by the interviews, most products do not reach this stage in their development without a customer being involved. Therefore, the four items used in the questionnaire address the product’s delivery, quality and ability to meet legislative requirements, as well as whether the commercialised product is significantly different compared to the initial concept.

SECTION 3: EXTERNAL ENVIRONMENT
The corporate and market environment within which the product is developed and launched can affect the outcome of the development project.

Corporate Characteristics
These include one measure of fit with financial resources, as well as three items about marketing and managerial synergies, and three about technical capabilities. The three marketing synergy items address the project’s fit with the firm’s current marketing capabilities. These items address the firm’s marketing research, management, and distribution skills and resources (Song and Parry, 1996; Cooper, 1979a, 1979b; Kleinschmidt and Cooper, 1995). The three technical capabilities against which
firm's assessed their fit were R&D/product development, manufacturing/production, and engineering.

**Market Environment**

Market potential refers to the attractiveness of the potential market measured using three items. These items assess the expected market size, growth, and customers potential need for the product (Cooper, 1979a, 1979b; Kleinschmidt and Cooper, 1995; Song and Parry, 1996). Market competitiveness is a measure of the intensity of competition in the product’s target market. There are eight items which refer to the intensity of price and non-price competition, the loyalty to and satisfaction with existing products, the number and strength of competitors, how similar competing products are and whether barriers to entry exist for new competitors (Cooper, 1979a; Maidique and Zirger, 1984; Zirger and Maidique, 1990; Song and Parry, 1996, 1997).

**SECTION 4: PERFORMANCE MEASURES**

This section looks at the performance or commercial outcome of the new product chosen, to be gauged on a number of different criteria. Respondents were asked to rate the product against all the criteria. The conceptual model presented in Chapter 4 (Section 4.2) includes three broad dimensions: financial, customer-based, and technical/product-based success. The multitude of issues comprising each of these dimensions can not be measured by a single question. Therefore, the constructs were operationalised by using a pool of items. More specifically eighteen measures were developed/adapted from the literature (Hart, 1992; Griffin & Page, 1993, 1996) and the exploratory research. Financial performance was measured using four items: profitability, margin goals, break-even time, and return on investment. Customer/marketplace measures refer to market share goals, unit volume, revenue goals, and customer acceptance and satisfaction. Technical/product-based success is assessed via the quality of the product (reject and warranty), it's performance against specifications, whether it was considered to be a technological success, and whether it was developed within budget constraints and time scales.
There are also two other items which measure the degree to which the product opened a window of opportunity for the respondent firm in terms of a new product category or a new market opportunity.

There has also been issues raised about the use of indirect measures versus direct measures. There are problems associated with both, however, Hart’s (1993) study concludes that “... asking an indirect, relative question about sales growth yields a picture consistent with a direct measurement. Furthermore, the experience of the authors in investigating low response rates suggests that indirect may be more fruitful in accessing data” (1993 : 35). Perceived measures of success have also been shown to be highly correlated with the objective measures of financial performance by Song and Parry (1996). A major advantage of using a scale of perceived measures of success is that it permits comparison across firms (Calantone et al., 1996). This has been corroborated by Song and Parry (1996) who suggest that subjective scales enable the researcher to compare across firms, based on firms’ individual assessment within their respective industries, cultures, time horizons, economic conditions and goals. This is demonstrated again by Song and Parry (1997) who found that subjective scales were strongly correlated with objective measures of financial performance.

**SECTION 5: BACKGROUND INFORMATION**

Background information was also collected in order to identify whether firm size or orientation affects the findings (Mishra et al., 1996). Several investigations have used number of employees (e.g. McConnell, 1979; Bilkey, 1985; Hart et al, 1994) and/or annual sales volume in money terms (Rabino, 1980) as size indicators. The present questionnaire includes both measures and, in addition, it includes: spending on R&D as a percentage of turnover; firm orientation in terms of whether they are market or technology driven and whether products were aimed at mass or niche markets.

Many elements of successful NPD are “soft” in nature (such as process execution, organisation, strategy, culture and commitment) and in order to assess these more subjective issues, the researcher must rely on the personal judgements of the respondents (Cooper and Kleinschmidt, 1995). Montoya-Weiss and Calantone (1994) identified, in their meta-analysis, that the issues of data collection have not been adequately addressed. The level of respondents was given in only 36% of the studies.
whereas, the functional role of the respondents (i.e. Marketing, R&D, Management) was reported in 74.5% of the studies. Of these functional respondents, 40% were listed as managers, but this also creates confusion about what a "manager" category actually contains, whether high level or lower level. Therefore, this section also includes questions about the respondent and his/her job (Pugh and Morley, 1988). Three questions were asked to obtain information on their job function and title and their level of management (Montoya-Weiss and Calantone, 1994).

5.5.4 FORM OF RESPONSE
In general there are two types of response form, open-ended and closed-ended (Luck & Rubin, 1987; Aaker et al., 1995). Open-ended questions are where respondents are free to reply in their own words rather than being influenced by pre-specified alternatives (Churchill, 1995). Closed-ended/structured questions specify the set of response alternatives and the response format. Respondents are asked to choose the alternative which best describes their position on the subject (Churchill, 1995; Malhotra, 1996).

Open-ended questions were used mainly for general firm information e.g. number of employees, turnover, and percentage spend on R&D. An open-ended question was also used to identify product type (section 1 of questionnaire). There is much less reluctance to provide exact figures to open-ended questions when studies promise anonymity/confidentiality and are conducted by means of a mail survey (Aaker et al., 1995). However, coding is more time-consuming (Churchill, 1995; Jones, 1981). Also, unstructured questions could give extra weight to respondents who are more articulate (Aaker et al., 1995), however, this is not thought to be relevant because the open-ended questions used in this study are only about company information.

Closed-ended questions are divided into three types: multiple choice/multichotomous questions; dichotomous questions; and scales (Churchill, 1995; Malhotra, 1996), and were used for the majority of questions in this study. Regardless of the type of closed-ended format, the advantages are the same. These questions are: easier to answer; require less effort by the interviewer; and make tabulation and analysis easier (Aaker et al., 1995). There is less potential error because of the way the questions are asked and responses recorded. They take less time to answer and respondents’
answers are directly comparable (assuming each respondent interprets the words the same) (Malhotra, 1996; Aaker et al., 1995). "Comparability of respondents is an essential prelude to the use of any analytical methods" (Aaker & Day, 1990: 242).

The advantages of multiple-choice questions are that they are relatively short and easy to answer, easy to analyse and provide specific answer alternatives for respondents, indeed Tull & Hawkins argue that multiple response questions "are almost essential for securing adequate co-operation in self-administered surveys" (1993:352). Their drawbacks are that the researcher has to provide an exhaustive and mutually exclusive list of all relevant alternative responses (Luck & Rubin, 1987). The options provided in the checklists for the five multi-choice questions included in the questionnaire were derived from the theoretical and empirical literature and the qualitative study and in order to provide the respondents with an exhaustive list. Care was also taken to only include "relevant categories" (Aaker et al., 1995:297). However, the option "other - please specify" was also included for the ‘Source of the new product idea’ and job function checklists, because the researcher could not be certain that all important alternatives had been listed (Oppenheim, 1992; Malhotra, 1996).

Dichotomous questions have only two response alternatives (Churchill, 1995) and are used when only two logical answers exist (Aaker et al., 1995). In the case of this questionnaire only one dichotomous question was asked: "This product was considered to be a: Success, Failure”.

**Scales**

“Single items are notoriously unreliable” and “imprecise”, therefore, scales are used to represent constructs which “are broad in scope and not easily assessed with a single question” (Spector, 1992:4). A variety of methods have been developed to measure a sample of beliefs toward the attitude objects which are then combined into some form of average score. The three most commonly used scales are: summated/Likert scale; semantic-differential scales; and Stapel scales (Churchill, 1995; Luck and Rubin, 1987).

In order to develop a research instrument that has valid and reliable measures, Churchill’s (1979) paradigm for developing measures of marketing constructs was
followed. There are many variations of this methodology but they tend to follow a similar theme (DeVellis, 1991; Spector, 1992, Malhotra, 1996).

This iterative, multi-step process, identified in figure 5.2 was used to develop multiple-items that characterise the constructs identified in chapter 4 to ensure the validity of the measurement scales.

**Figure 5.2 Suggested Procedure for Developing Better Measures**

![Figure 5.2 Suggested Procedure for Developing Better Measures](source)


Likert scales ask the respondents to indicate a degree of agreement or disagreement with a series of statements about the items from "strongly agree" to "strongly disagree" (Churchill, 1995; Oppenheim, 1992; Aaker et al., 1995; DeVellis, 1991). This research has used Likert scales for most of the questions. These scales have several advantages: they are easy to construct and administer, and the respondents have no problems in understanding them (Malhotra, 1996); respondents have no problem finding opposite terms in the scale and there is only one, uniform set of response categories (Luck and Rubin, 1987); they also provide clarity i.e. only one description for each item (Luck and Rubin, 1987) and continuity because of the use of
the same scale responses, both of which stimulate responses because they make the questionnaire easier to respond to.

When constructing these scales a researcher must decide: 1) the number of scale categories to be used; 2) whether the scale is balanced or unbalanced, (i.e. the number of favourable versus unfavourable categories); 3) odd or even number of categories; 4) forced versus non-forced choice; 5) the nature and degree of the verbal description; 6) the physical form of the scale (Malhotra, 1996).

In general, the more scale categories there are, the more precise the responses will be, however, respondents can get confused with too many to choose from (Aaker et al., 1995). A desirable quality of a measurement scale is variability. If a scale fails to discriminate differences in the underlying attribute, its correlation’s with other measures will be restricted and its utility limited (DeVellis, 1991). Therefore, one way to increase the opportunity for variability is to have lots of scale items. However, the researcher also needs to consider the “respondents’ ability to discriminate meaningfully” (DeVellis, 1991; 65). Any variance increases could be random (i.e. error). The respondents ability to discriminate can be improved by the wording or physical appearance of the scale. Descriptions shouldn’t be vague and response items should be presented with an obvious continuum (DeVellis, 1991).

Balanced scales are generally preferred to unbalanced because the first produce more meaningful results (Aaker et al., 1995), and were, therefore, used.

The choice of odd or even scale categories is dependent on the type of questionnaire, the type of response option and the investigator’s purpose (DeVellis, 1991). An odd number of choices implies a ‘neutral’ point (DeVellis, 1991; Spector, 1992). An even number forces the respondent to make a commitment to one extreme or other (even if weak) and are only used when the researcher believes that no neutral or indifferent response exists (Malhotra, 1996). For this study equivocation was thought important because no “not appropriate” choice was being given i.e. a forced choice. Therefore, respondents would be expected to mark the middle point if they had no opinion (Malhotra, 1996). Thus, a difference can be determined between a ‘no opinion’ response and where respondents are simply reluctant to answer (missing values) (Malhotra, 1996).
The standard Likert scale was used for the first scale with just the end points of ‘strongly disagree’ and ‘strongly agree’ being marked and using numbers to represent the response options so as not to clutter the questionnaire too much. The second scale used ‘not important’ to ‘very important’ end points.

Another source of error associated with scales is that respondents tend to reply to scale items in a ‘socially desirable’ way, i.e. “the tendency to reply ‘agree’ to items that the respondents believe reflect socially desirable attitudes, in order to show themselves in a better light” (Oppenheim, 1992:181). Therefore, it is best to avoid this source of error through good questionnaire development (Yu and Cooper, 1983). However, the researcher must also be aware, when analysing the results of these questions, that this may be a problem.

Bearing all these points in mind, an eleven point likert scale (0 - 10) was chosen for the instrument. This is in keeping with past studies (Cooper, 1979a, 1979b; Cooper and Kleinschmidt, 1995; Calantone et al, 1996; Song and Parry, 1997). The second scale was also eleven point in order to make the two scales comparable (Kleinschmidt and Cooper, 1995).

The type of questions asked should be tailored to the specific information needs of the project as they also determine the measurement levels of answers (Churchill, 1995; Luck and Rubin, 1987). This partly determines the applicability of statistical analysis techniques (Kinnear & Taylor, 1996). Therefore, care was taken to ensure the highest level of measurement possible was used. In most cases this was interval, although, the question arises as to whether Likert Scales are interval or ordinal. Using ordinal measures as if they were interval can cause problems when interpreting the data (Diamantopoulos and Schlegelmilch, 1997). If one adopts a ‘purist’ view then responses should be treated as ordinal unless it can be proved otherwise. However, it is recommended that by appropriately numbering the response alternative on the scale it is possible to communicate to the respondent that the distances between the scale points are intended to be equal and have therefore, been taken as interval (Diamantopolous and Schlegelmilch, 1997; Nunnally and Bernstein, 1994).
5.5.5 QUESTION WORDING

The next step is to determine exact wording for questions. Poor question wording can lead to the respondent refusing to answer (item non-response) or answering incorrectly (measurement error), i.e. "the recorded or obtained score does not equal the respondent's true score on the issue" (Churchill, 1995:420). Therefore, care was taken to avoid the following: double-barrelled questions; ambiguous words and questions; leading or loaded questions; and questions involving implicit assumptions, alternatives or generalisations (Churchill, 1995; Aaker et al., 1995; Malhotra, 1996; Oppenheim, 1992).

The researcher needs to use words that respondents will be able to understand, and that are un-ambiguous i.e. a single meaning that will be understood by all respondents (Malhotra, 1996). Questions from past empirical studies and reports from practitioners suggested that that the language would be understood. Namely, the interview transcripts from the exploratory phase, as well as articles from the practitioner-oriented Journals, such as: Journal of Product Innovation Management, R&D Management, and books, such as, Hollins and Pugh, 1990; Urban and Hauser, 1993; Crawford, 1997; Souder, 1987.

The researcher also attempted to keep questions as brief as possible, as lengthy questions might deter respondents from answering or require them to read twice to understand (Luck & Rubin, 1987). However, it is not always the case that shorter questions are better, under certain circumstances, a question may have to be long in order to avoid ambiguity, but these should be the exception rather than the rule (Aaker et al., 1995). Therefore, while most questions were kept as short as possible, some were longer in order to improve their clarity. To help respondents with the understanding and completion of the questionnaire, the instructions were kept short and standardised.

Another issue is that not all questions should be phrased positively. "By varying the direction of questioning, bias produced by response tendencies will be minimised" (Spector, 1992: 24). However, acquiescence has not always been shown to be a problem with summated rating scales (e.g. Spector, 1987) and there are also problems associated with using negatively worded items (DeVellis, 1991). Reversal in item
polarity may be confusing to respondents, especially when completing a long questionnaire (DeVellis, 1991). Therefore, only a few negatively worded questions were included in the questionnaire. These are marked with a * in appendix 5.1.

5.5.6 QUESTION SEQUENCE

Literature suggests using simple, interesting, and non-threatening opening questions in order to gain the interest of respondents (Aaker et al., 1995; Churchill, 1995; Malhotra, 1996). The questionnaire should start with general questions then narrowing down to more specific ones later i.e. following a funnel approach (Churchill, 1995). Sensitive, difficult or dull questions should be placed later in the questionnaire and classification questions should be asked at the end (Churchill, 1995; Aaker et al., 1995). Once a rapport has been established and once respondents have become involved they are less likely to object or not finish (Malhotra, 1996). The question sequence has to follow a logical order enabling the participant to concentrate and thus, improve data quality (Peterson, 1982).

Order bias, i.e. “the possibility that prior questions will influence answers to subsequent questions” (Aaker et al., 1995:305) can also be a problem in mail questionnaires. Thus, care was taken to avoid order bias by placing questions where they were most appropriate. Therefore, some questions, whilst being part of one construct were added at different stages of the questionnaire in order to aid the completion, such as: “We carried out extensive modelling and prototyping before we had an agreed product design specification”. Obviously, this question is about prototyping but it is also about the product design specification which should have been developed at the concept generation stage and was, therefore, incorporated at this stage.

In order to apply these guidelines, the questionnaire started with the product characteristics, then questions about the development process were followed through in a logical order. Questions pertaining to more general corporate and market characteristics were put next and then the general firm characteristics last. The respondents were given the opportunity of obtaining a brief summary of the main study findings by providing their name and address on the last page of the
questionnaire. They were again reminded that the study would be completely confidential and were thanked for their contribution.

5.5.7 PHYSICAL CHARACTERISTICS OF THE QUESTIONNAIRE

This is the final step in the development of the questionnaire (Churchill, 1995). The actual questionnaire characteristics can affect the accuracy of replies (Churchill, 1995) and have been found to have a significant effect on response rate and data quality (Mayer & Piper, 1982, Jobber, 1989). This is especially important in self-administered questionnaires as, “the respondents are usually not motivated to do a good job. Therefore, the appearance can be influential in securing the co-operation of the respondent” (Luck & Robin, 1987: 197-198). Also, there is no interviewer to help the respondent (Luck and Rubin, 1987). Therefore, the layout of the questionnaire was kept consistent throughout to aid the respondent. The instructions for the two scales were kept simple and were shaded in order to make them stand out.

“To what extent does each statement correctly describe your product? 0 = Strongly disagree, 10 = Strongly agree” and “How important was this statement to a successful outcome? 0 = Not important, 10 = Very important”.

Methodological literature also suggests that questions should be numbered as it makes them easier to fill in, edit, code and tabulate (Churchill, 1995; Malhotra, 1996). However, it was thought that this would make the questionnaire too cluttered and complex at first glance which might put respondents off. Therefore, while sections were used, individual questions were not numbered.

The use of a postal questionnaire also requires consideration of a number of other factors, including questionnaire length and the cover letter, both of which impact on the response rate (Diamantopoulos and Schlegelmilch, 1996). Questionnaire size is important (Jobber, 1989) and Jobber and Saunders (1986) found that 58% of the mail surveys in an industrial setting were between four and ten pages. Yu and Cooper (1983:39), however, suggest that the length of the questionnaire is “nearly uncorrelated with the weighted average response rate associated with that length”. Herberlein and Baumgartner suggest that length may even have a positive effect, “length, then, may signal importance to the respondent, possibly even enough to overcome the costs associated with it” (1978:459). The questionnaire was
originally eleven pages long, in a booklet format which is thought to suggest quality (Churchill, 1995), and presented landscape due to the amount of information for each item (see appendix 5.2). This was due to the use of two scales which made the questionnaire too cluttered when presented portrait (Jobber, 1985).

The cover letter for the research can also affect the acceptance of the questionnaire (Churchill, 1995). Therefore, it is vital that the cover letter "convinces the designated respondent to co-operate" (1995: 432) and includes all the important points identified by methodological literature (Churchill, 1995; Diamantopoulos et al., 1991; Diamantopoulos and Schlegelmilch, 1996; Oppenheim, 1992). This will be discussed in greater detail in 5.6.2.1 (Sample selection and administration).

5.6 QUESTIONNAIRE PRETESTING

"Data collection should never begin without an adequate pretest of the instrument" (Churchill, 1995:436). This is because, "no amount of intellectual exercise can substitute for testing an instrument designed to communicate with ordinary people" (Backstrom and Hursch, 1963).

It is especially important to pretest novel research projects (Peterson 1988) and this research, while it is based around well documented research, is novel in that the questionnaire is looking in more detail at the internal project variables and has been modified for a different industry and country setting.

The purpose of pre-testing “is to ensure that the expectations of the researcher, in terms of the information that will be obtained from the questionnaire, are met” (Aaker & Day, 1990: 257). Literature suggests that a “pretest can be used in a limited way and be restricted to the testing of the questionnaire alone” (Reynolds et al, 1993: 172) or it can represent “a test of the entire process of data collection and even first steps of analysis” (Galtung, 1967: 137).

When the final survey is not going to be carried out using personal interviews several authors (Peterson, 1988; Churchill, 1995) recommend two pre-tests: “A distinction should be made between a pre-test and a pilot survey” (Green et al., 1988 : 185). First personal interviews should be undertaken. Advantages of personal interviews are that they “enable the interviewer to notice reactions, hesitations, and other cues by the
respondent that could not be obtained via telephone or mail (Hunt et al., 1982: 270) while “the purpose of the second pre-test is to uncover problems unique to the mode of administration” (Churchill, 1995: 438).

“Using ‘expert’ pretest respondents (e.g. researchers not directly involved with the research) as recommended by Hague (1987b) and Green et al., (1988) seems to be a good strategy for enhancing error detection” (Diamantopoulos et al., 1994 : 309).

A pilot survey is a small scale test of the medium to be employed in the main study, including all the activities that will go into the final study. The sample, while remaining small, should mirror that of the main study and cover all subgroups of the target population. It should also be determined as a function of the complexity of the instrument and diversity of the population (Tull and Hawkins, 1990).

Therefore, the questionnaire was first pre-tested by ‘experts’ (section 5.6.1) and then two independent mail pilots (sections 5.6.2 and 5.6.3) were undertaken.

### 5.6.1 INITIAL PRE-TEST

The final instrument was pre-tested by ten ‘experts’ taken from both industry and academia (six from industry and four from academia) during August and September 1997. The findings of a study by Diamantopoulos et al “clearly indicate that familiarity with questionnaire design and knowledge of the subject of the questionnaire are relevant for the detection of faulty questions in the context of pre-testing” (1994 : 308). The reason why both academic and industry ‘experts’ were chosen is that industry ‘experts’ were assumed to have a more in-depth knowledge about the subject but less knowledge about questionnaire design, and the academic ‘experts’, whilst also having knowledge of the subject, were assumed to be more knowledgeable about questionnaire design and the errors which can occur.

Two procedures are suggested for determining the respondents' reactions to the questionnaire: Protocol (having the respondent think out loud as he/she answer each question); and debriefing (discussing questions and associated problems after the entire questionnaire had been completed) (Hunt et al., 1982; Aaker et al., 1995; Malhotra, 1996). Both methods have associated problems. The problem with protocol interviews is that the act of thinking consciously about the decisions being
made may alter the decision and hence the response given; and the problem with the
debriefing method is that for a long questionnaire problems encountered near the
beginning may be forgotten or their importance diminished by later issues. It was
hoped that through the use of both techniques the problems associated with each could
be minimised. Therefore, both methods were used, five interviews were carried out
using protocol procedures and five by the debriefing method. The pretest letter used
is shown in appendix 5.3.

Most interviewees remarked that they had no problems with most of the question
wording, and for the few that were commented on changes were made. These were:

- For section 1, respondents commented that there were a lot of statements for the
  product advantage section and suggested the removal of two items. ‘The product
  provided sustainable competitive advantage’ was seen as very general and difficult
to quantify by the pretest respondents. The question about whether the product
was ‘planned to solve a problem the customer was having with another company’s
product’ was not thought relevant for this industry. The addition of ‘and/or’ in the
item ‘this product improved the customers’ operation (product or process)’ was
suggested to improve the clarity of the question. The item ‘Competing products
had a service and technical support advantage over this product’ was identified as
not being particularly applicable for automotive component suppliers and was,
therefore, taken out of the non-product advantage list of items. They also felt that
asking how many man-months the project had taken was quite personal and
respondents might be reluctant to answer. Therefore, it was removed from the
questionnaire.

- The removal of “integrated and” for two project organisation questions because it
  made the questions difficult to answer because they were double-barrelled, i.e.
  “The customers were integrated and actively involved in the product development
  process”. It was thought by the pretest respondents that whether the customers
  were ‘actively involved’ was more important. Two other items were seen to be
  unnecessary. The first was whether ‘the customers were involved in the risk
  sharing and management of the project’. Respondents identified that whether the
  product was developed as a joint venture, and who with, was a better way of asking
  for this information. The second item was whether ‘the project was undertaken by
a cross-function, multi-disciplinary team’ because all the industry pretest respondents identified that this would be true for all firms in this industry and was, therefore, not particularly relevant to the overall focus of the study.

- The respondents suggested that less choices were necessary for the source of the new product idea and that they should be asked as individual yes/no questions because rating the involvement of each choice was too difficult.

- In the market assessment section, the wording for item 4 was changed to make it easier to read. "We did not know how much the customer would pay for such a product (their price sensitivity)" instead of "How much the customer would pay for such a product (their price sensitivity) was not known".

- The item “The required benefits to the customer had been determined”, asked in the concept generation section was seen as repetitive in that it had, essentially, already been asked by the item, “We understood our potential customers’ needs, wants and specifications for this product”, in the market assessment section.

- The inclusion of the words “detailed” in question 1; and “prior to development” in question 2 of the project planning subsection were also suggested.

- In the Development Programme section, the question “the product was developed on a design for manufacture basis” was seen as superfluous, when having just asked a question about whether “the manufacturing process was developed in parallel with the product”. They were not seen as distinct enough to warrant asking both questions. Therefore, the question about ‘design for manufacture’ was removed. The word "all" was added to the questionnaire about outsourcing of prototyping to make it easier to answer.

- For the product testing and validation section the words ‘to determine performance against specifications’ were added to the third item to make the question clearer. The item “we submitted products to customers for in-vehicle testing” was changed because the original question was worded to suggest a simple yes/no response which did not provide enough response options to appropriately capture the respondents possible answers. The pretest sample identified that they would want to grade the involvement of the customer, therefore, item 5 was replaced with "Customers were highly involved in the product testing".
• In the market launch section, the question ‘the product met all the legislative requirements’ was added to the as a result of the pretest and the question about ‘verifying long-term production stability and capability’ was removed because it was seen as very similar to the question in the previous section about running ‘capability studies to optimise the production process’.

• The question wording for section 3, the company environment, was found to be long and repetitive. The questions were also identified to be double-barrelled - including both skills and resources - and it was thought that this would make it difficult for respondents to answer. Therefore, the initial sentence of ‘The following company capabilities were more than adequate for this project:’ was added at the start of the section and the questions only included the relevant capabilities, whether skills or resources, which were identified as appropriate by the pretest respondents. The item about technical support and customer services was also identified as irrelevant for this industry and was, therefore, removed.

• The only problem items in section 4 - the external environment were the items, “the new product market mainly involved new customers to the company” and “Users needs changed rapidly”. These was seen as fairly irrelevant given the industry under investigation and were removed.

• For the Background Information, section 6, the use of open-ended questions was suggested for the first three items as the tick box options being used reduced the level of measurement and, therefore, the analytic techniques that could be used. The addition of a question about the technology level of the product was suggested because it was felt to be an important variable by which to categorise firms.

In terms of the overall questionnaire, most did comment that the questionnaire was quite long, which was understandable given that it took between 50 minutes and one hour to complete. However, the consensus was that all the information was relevant, no-one thought that the questionnaire was prohibitively long and due to the importance of the research to the industry they suggested that it should not be a barrier to obtaining responses.

The updated version of the questionnaire, including the minor working corrections was then used in the mail pilot (see appendix 5.6).
5.6.2 MAIL PILOT 1

5.6.2.1 Sample Selection and Administration

Pretest sample sizes are generally ‘small’ (Zaltman and Burger, 1975) and should cover all subgroups of the target population (Green et al., 1988). While some researchers provide specific figures, or ranges of figures (Hague, 1987a; Luck and Rubin, 1987, Kinnear and Taylor, 1987; Boyd et al., 1989), Hunt et al. (1982) suggest that the sample is not fixed but “should be a function of the instrument and the target population” (1982:270). Long complex instruments require larger pretests, however, the pretest sample size also depends on the sophistication of the target population. The more sophisticated the target population, the smaller the required sample size (Hunt et al., 1982). The instrument to be tested was long and the target population was assumed to be reasonably sophisticated, therefore, a random sample of 50 firms was selected from the 907 possible respondents in the SMMT database.

Each out-going envelope contained two identical questionnaires (one for a successful new product development and one for a failure) with a pre-paid envelope attached to each (addressed to author), for the return of the questionnaire. Lowering the cost of participating in the study in this way has been identified as one means of improving the response rate (Herberlein and Baumgartner, 1978, Jobber, 1986; Diamantopoulos and Schlegelmilch, 1996). All questionnaires were sent with a dated, personalised cover letter printed on University headed paper, signed individually (Diamantopoulos and Schlegelmilch, 1996; Churchill, 1995). Each letter (appendix 5.4) declared the identity of the research; the purpose of the research; the role of the sponsoring organisations; the importance both to the respondents and the researcher, and information on the completion of the questionnaire (Diamantopoulos and Schlegelmilch, 1997, Churchill, 1995; Jobber, 1986). Care was taken when writing the cover letter to include important points, including: the importance of the research as well as the purpose of the research; the importance of the recipient and replies in general; how the recipient would benefit; how the recipient was selected; assurances of confidentiality and anonymity; and personalisation (Diamantopoulos et al., 1991; Diamantopoulos and Schlegelmilch, 1996; Oppenheim, 1992; Churchill, 1995). In front of this was a letter of sponsorship from MIRA and SMMT, signed by the Managing Director, MIRA and the Head of Policy, SMMT (Appendix 5.5). This
highlighted the importance of the study and asked for respondents co-operation. This form of sponsorship is suggested to increase the response rate (Diamantopoulos et al., 1991; Oppenheim, 1992).

As discussed in the section 5.4 (Sample), the contact names on the database provided by the SMMT were not necessarily the correct respondents. Although this was not ideal, it was felt that the contact names were still the most useful contact due to their knowledge of the SMMT and the senior status of their positions. As Diamantopoulos and Schlegelmilch (1996) suggest, the likelihood of participating in a mail survey is higher if it is conducted by, or in this case, sponsored by, an organisation to which the respondent is currently associated or familiar with.

This is also consistent with Hultink and Robben (1995), whose instructions asked for the questionnaires to be passed along to the Research and Development Manager, or whoever had a responsibility for NPD within the organisation. They were then asked to identify a clearly successful and failed project and distribute the questionnaires to the appropriate project manager/project leader who had been responsible for the project. The questionnaire pilot was sent on the 1st November, 1997.

5.6.2.2 Efforts to increase the response rate

The questionnaire was long, therefore, it was emphasised in the cover letter and on the front of the questionnaire that it would take less than 1 hour to complete. The importance of the study was also emphasised, and an offer of summary results was made as an incentive to respond. Diamantopoulos and Schlegelmilch (1996) found that an offer of summary results positively influenced the likelihood of responding. However, as this can work against any positive effects of anonymity (Jobber, 1986), these results were only offered to those who were prepared to fill in their details on the questionnaire. Care was also taken to emphasis that only summary findings would be available, and that no individual respondent or company would be identified (Jobber and O'Reilly, 1998). The interviewees from the exploratory study did suggest that the findings would be of interest to the industry and that firms would be likely to want a copy. This is consistent with studies by Calantone et al. (1996) and Song and Parry (1997).
Respondents were contacted by telephone two weeks after initial mailing to encourage them to return the questionnaire. These calls were time consuming, due to difficulties associated with reaching busy managers by telephone. However, they did provide an opportunity to explain the importance of the study again and were worthwhile in terms of identifying reasons for non-response (Section 5.6.2.3).

5.6.2.3 Response Analysis Of Mail Pilot 1

Of the 50 firms contacted, no responses were returned. Therefore, the initial response rate was 0%.

A telephone follow-up was carried out two weeks after the initial mailing. The telephone follow-up cast doubts on the quality of the SMMT database as a sampling frame. Out of the 50 firms contacted, two no longer existed, and 26 firms identified themselves as not doing NPD and were, therefore, ineligible. This has implications for the calculation of the effective response rate as discussed later in section 5.8.2.1.

This left the author with 22 potential respondents. Out of these remaining 22, seven had the wrong contact names, two had wrong contact addresses, and two had both a wrong contact and a wrong address. One did not recall having received the questionnaire but was interested in being involved and asked for another copy and one admitted having put it in the bin, but after a discussion about the importance and the likely results agreed to participate and asked for another copy. For the eleven wrongly contacted respondents, pre-notification telephone calls were made to identify who would be the correct contact, whether they undertook NPD and were therefore, appropriate respondents, and whether they were prepared to participate in the study. Of the eleven contacted, eight agreed to participate and three identified themselves as not being eligible (ineligible firms totalled 31). A new copy of the questionnaire was sent out to the eligible eight firms. Of the rest of the firms (nine in all), six confirmed that they had received the questionnaire and promised to return it completed, two identified that they were too busy, and the author was unsuccessful in contacting the relevant person in one of the companies, despite repeated attempts. A second follow-up was undertaken for the respondents prenotified during the first follow-up in order to boost returns and to identify reasons for non-response. Table 5.2 and figure 5.3 provide a breakdown of the reasons for non-response.

131
Table 5.2 - Reasons for Non-Response

<table>
<thead>
<tr>
<th>Reason</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not appropriate</td>
<td>31</td>
</tr>
<tr>
<td>Couldn’t contact</td>
<td>1</td>
</tr>
<tr>
<td>Too busy</td>
<td>2</td>
</tr>
<tr>
<td>Not returned</td>
<td>16</td>
</tr>
</tbody>
</table>

Figure 5.3 - Summary of Breakdown of Responses to Pilot 1

The pre-notification of wrongly contacted respondents and the telephone follow-up efforts were not effective in stimulating responses. However, they did provide some useful information on reasons for non-response and also cast doubts on the quality of the SMMT database as a sampling frame.

Prior to a second pilot survey one major modification were made to the questionnaire (see appendix 5.7). The second scale that was being used to assess the importance of each statement was removed because the telephone follow-up revealed that the questionnaire was too long and respondents found the second scale confusing and difficult to answer.
Efforts were also made to improve the sampling frame as well. First the contact at the SMMT provided a booklet with more specific details about the companies included in the database. This made it possible to remove obviously non-eligible firms such as, finance houses, leasing firms, and distributors. Then, telephone calls were made to 325 of the remaining 400 firms (telephone numbers were not available for all firms and some could not be contacted, despite repeated attempts) to confirm the names of respondents, confirm company names, and, if possible, ascertain whether companies were eligible. If new SMMT names were not known then firms were asked to identify R&D managers, if possible. This reduced the sample to 350 firms.

Because of the lack of responses to the first pilot and the extent of the changes made to the questionnaire, it was felt that a second pilot of the questionnaire was necessary.

### 5.6.3 MAIL PILOT 2

The second pilot on the 2nd February 1998 was sent out to 30 randomly selected respondents from the new database of 350 firms on the 2nd February 1998. The administration was exactly the same as for the first pilot survey.

Only one firm response was received and this only provided details for a successful project. Therefore, the unadjusted response rate was 3%.

This time a follow-up mailing, including a duplicate questionnaire, was used as the first technique for stimulating responses. Fox et al (1988) identify that they yield significantly higher return rates than telephone calls and were more cost effective due to the amount of attempts required to contact the respondents in the first pilot. This was sent two weeks after the initial mailing. However, no more responses were received as a result of the mailed follow-up. Therefore, telephone follow-up calls were made two weeks after the mailed follow-up, firstly, to stimulate responses, but also to try to identify reasons for non-response. The telephone calls identified that five out of the 30 were not eligible. Of the 24 non-respondents, two stated that they were too busy to respond, eight stated that they had received the questionnaire and promised to return it completed. For five of the firms only secretaries could be contacted, despite repeated attempts, who confirmed that the questionnaire had been received, and that the firms were eligible to respond. Six respondents did not recall having received the questionnaire (one of which had a wrong contact name). For
these six the telephone calls were again used to prenotify the respondents, explaining
the objectives of the study, it’s importance and what the study entailed. All six agreed
to participate and a new copy was sent out. The author was unsuccessful in contacting
four firms. As with the first pilot, a second follow-up was carried out for the
respondents prenotified during the telephone follow-up but no more responses were
received. Table 5.3 and figure 5.4 provide a summary of the responses to the second
pilot.

Table 5.3 - Reasons for Non-Response

<table>
<thead>
<tr>
<th>Reason</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Couldn't contact</td>
<td>4</td>
</tr>
<tr>
<td>Not appropriate</td>
<td>5</td>
</tr>
<tr>
<td>Too busy</td>
<td>2</td>
</tr>
<tr>
<td>Not returned</td>
<td>19</td>
</tr>
</tbody>
</table>

Figure 5.4 - Summary of Breakdown of Responses to Pilot 2

The telephone follow-ups were again not effective in stimulating responses, despite
the positive feedback to the study topic and the opportunity to receive summary
findings.
The effective response rate \(^2\) was:

\[
\frac{1}{(30 - 5)} = 4\%
\]

Obviously there was a response problem for both pilot surveys, however, the telephone follow-ups for the second pilot were less informative as to why firms were not responding.

5.7 EFFORTS TO IMPROVE RESPONSE RATE

All of the issues involved in the developing of a questionnaire affect the response-rate and non-response minimisation is important because of the possibility of non-response bias. One strategy for minimising non-response is through careful design and execution of the survey (Yu and Cooper, 1983).

Due to very low response rates in the pilot tests it was necessary to identify other possible ways for improving response rate in the main study, beyond what had already been done, i.e. prior telephone calls, pre-paid reply envelopes, offering a summary of the results, confidentiality and anonymity (Schlegelmilch and Diamantopoulos, 1991).

Prior contact by telephone increases the response rates (Jobber, 1986; Jobber and O'Reilly, 1998; Schlegelmilch and Diamantopoulos, 1991). However, there is no consistent picture (Schlegelmilch and Diamantopoulos, 1991; Jobber and O'Reilly, 1998). Diamantopoulos and Schlegelmilch (1996) noted an indifference by the company sample to all forms of prenotification, which was thought to reflect an unwillingness by respondents to commit themselves to participating in a survey before seeing the questionnaire.

\(^2\) Effective response rate = total number of completed questionnaires over the total number of eligible respondents (Churchill, 1995: 661)
Given the large sample size, the cost constraints, and the difficulties with obtaining access to busy managers in both pilot follow-ups, it was impossible to carry out pre-notification for all respondents (Schlegelmilch and Diamantopoulos, 1991). However, despite poor responses to the prenotification calls in the pilot studies, this was still seen as the most likely method of obtaining responses. Therefore, two slightly different forms of prenotification were attempted during April and May, 1998. The first involved MIRA sponsors contacting respondents they knew personally and asking them if they would be prepared to participate in the study. Those who agreed were sent the questionnaire package, including pre-paid reply envelopes (addressed to author). Of the 20 firms contacted in this way, nine responded. This provided the author with twelve questionnaires, nine of which were usable. The second involved the author contacting respondents, whose names had been provided by MIRA and using their names when approaching the respondent. As with the previous pre-notification telephone calls, the objectives of the study were explained, its importance and what participating in the study entailed. However, of the ten firms contacted in this way, three did not wish to participate (they were too busy) and the other seven, who all agree to participate, did not return any completed questionnaires.

The cover letter was also shortened, whilst making sure that it still retained all the important issues, a copy of which can be found in Appendix 5.8. However, one sentence was added by the author. After the sentence about passing the information on to the appropriate person, the author also included “If this is not possible, please could you return the information in the pre-paid envelope supplied” to try to reduce the number of respondents who simply ‘binned’ the information. These changes reduced the length and complexity of the cover letter. To compensate for the loss of some information in the cover letter, the instruction paragraphs on the first page of the questionnaire were expanded into a full explanation sheet.

Monetary incentives were too expensive and according to Diamantopoulos and Schlegelmilch, (1996) are doubtful motivators. Some also suggest the inclusion of cut-off dates for replies (Futrell and Hise, 1982). However, Fox et al, (1988) did not find that this increased the response rate significantly, and other authors have found
that “the creation of a sense of urgency is unlikely to encourage response” (Diamantopoulos and Schlegelmilch, 1996: 520).

As with both pilots respondents were promised a summary of the results and freepost envelopes were supplied.

5.8 MAIN SURVEY

Because of the poor response rate to the second pilot and difficulty in obtaining reasons for non-response no more changes were made, at this stage, to the actual questionnaire in terms of question wording, sequence, inclusion. However, two individuals during the telephone follow-up did allude to the MIRA sponsorship as an issue, asking, ‘how they were involved in the research’. This, coupled with the poor response rate from the firms prenotified by MIRA lead the author to consider the possibility that the sponsorship was having a negative impact. Therefore, a decision was made to remove all sponsorship logos from the questionnaire and not to send the package out with the covering sponsorship letter. However, the brief discussion about the sponsorship of the project by MIRA and the ESRC was left in the cover letter.

The revised version of the questionnaire used for the main study can be found in appendix 5.9. The administration of the main study was kept the same and the questionnaire package was mailed to 290 firms on the 10th June 1998.

5.8.1 FOLLOW-UP REMINDERS

Mail follow-ups (Furse et al, 1981; Kephart and Bressler, 1958, Watson, 1965), postcard reminders and follow-up telephone calls have all been found to increase response rates. There are suggestions in the literature that this should be done as frequently as is necessary for an acceptable response rate (Herberlein and Baumgartner, 1978), however, there is a danger that if this is too frequent the researcher will annoy the respondents.

A follow-up reminder letter was sent 15 days after the initial mailing, to increase the response rate. This included duplicate questionnaires which is perceived to be the most effective method of increasing the response rate (Diamantopoulos and Schlegelmilch, 1996; Jobber, 1986).
This boosted the returns from 36 (received after the initial mailing) to 59. It also encouraged ineligible firms to return the information. Most of these firms also enclosed a letter explaining why they were not eligible to participate in the study. A second follow-up, again including a duplicate questionnaire was sent 25 days after the first follow-up. This again boosted the responses and reasons for non-response.

### 5.8.2 RESPONSE ANALYSIS OF MAIN STUDY

In all, 70 questionnaires were returned from 57 firms, 69 of which were fully usable (the breakdown of these was 55 successes and 14 failures). Due to wording on the cover letter and the repeated follow-up reminders 48 of the 290 firms returned the information providing reasons for non-response. Of the ineligibles, seven identified themselves as not undertaking NPD, 20 were not automotive component suppliers, five were closed and 16 identified themselves as not being able to identify relevant projects. The author also received 21 blank responses, and seven responses for firms who were too busy to participate. Table 5.4 provides a breakdown of the returned questionnaires and Table 5.5 identifies the reasons for non-response.

#### Table 5.4 Breakdown of Returned Questionnaires

<table>
<thead>
<tr>
<th></th>
<th>Initial Mailing</th>
<th>Follow-up 1</th>
<th>Follow-up 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usable</td>
<td>35 (28 S, 7 F)</td>
<td>23 (20 S, 3 F)</td>
<td>11 (7 S, 4 F)</td>
<td>69 (55 S, 14 F)</td>
</tr>
<tr>
<td>Non-eligible</td>
<td>36</td>
<td>9</td>
<td>3</td>
<td>48</td>
</tr>
<tr>
<td>Returned blank</td>
<td>10</td>
<td>5</td>
<td>6</td>
<td>21</td>
</tr>
</tbody>
</table>

(S = Success, F = Failure)

#### Table 5.5 - Reasons for Non-Response

<table>
<thead>
<tr>
<th>Reason</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Automotive Component Suppliers</td>
<td>20</td>
</tr>
<tr>
<td>Don't do design/Only Manufacture</td>
<td>7</td>
</tr>
<tr>
<td>Not Relevant</td>
<td>16</td>
</tr>
<tr>
<td>Closed</td>
<td>5</td>
</tr>
<tr>
<td>Too Busy</td>
<td>7</td>
</tr>
<tr>
<td>Blank Returns / No Explanation</td>
<td>21</td>
</tr>
</tbody>
</table>
5.8.2.1 Response Rate

Therefore, 78 usable questionnaires were returned, including the nine usable responses from the firms prenotified by MIRA, from 66 firms out of a total sample of 320 (290 from main study, plus the 30 prenotified firms).

Due to the range of methods that researchers employ to calculate response rates, if just a response rate is given, the reader lacks such information as "how the rate was computed, how many non contacts were involved, and how many contacts were ineligible" (Wiseman and Billington, 1984:336). In order to try and overcome the confusion surrounding the calculation of response rates a special Council of American Survey Research Organization (CASRO) task force tackled this problem by developing a standard definition of response rate, and identified that:

\[
\text{response rate} = \frac{\text{number of completed interviews with responding units}}{\text{number of eligible responding units in the sample}}
\]

However, the key is in the proper handling of eligibles (Churchill, 1995). When using eligibility requirement the researcher must first estimate the number of eligibles among the non-respondents using the eligibility percentage.

\[
\text{Eligibility percentage} = \frac{\text{number of completed responses}}{\text{number contacted and successfully screened (i.e. completed or ineligible)}}
\]

For this study the eligibility percentage was \( \frac{69}{(69+48)} = 59\% \). Therefore, the number of eligible responding units in the sample was 171 and the effective response rate was:

\[
\frac{69}{69 + (145+21)(0.59)} = 41.3\%
\]

While this response rate is lower than the figures quoted by some other studies in this area (e.g. 81\% by Song and Parry, 1996) it is comparable with other surveys conducted in an industrial setting (Jobber and Blaesdale, 1987).
5.8.2.2 Success Versus Failure Responses

As can be seen from the breakdown of returned questionnaires shown in Table 5.4 it was identified very quickly that there were much fewer responses for failures than for successful new products (79.7% successes, 20.3% failures). Therefore, the researcher conducted a telephone follow-up of those firms who had only filled in a questionnaire for a successful development project and who had provided contact details. 25 telephone calls were made to try to: 1) increase the number of questionnaires describing failed development projects; and 2) identify reasons for not returning information for failed products.

Only one extra questionnaire detailing a failed project was received as a consequence of the follow-up. All the other firms (24 in all) provided reasons for non response (see Table 5.6).

Table 5.6 - Reasons for Not Returning Information on Failures

<table>
<thead>
<tr>
<th>Reason</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don't have failures</td>
<td>5</td>
</tr>
<tr>
<td>No suitable example/respondent had no experience</td>
<td>4</td>
</tr>
<tr>
<td>Have less successful projects</td>
<td>7</td>
</tr>
<tr>
<td>Kill project prior to launch</td>
<td>4</td>
</tr>
<tr>
<td>Confidentiality</td>
<td>4</td>
</tr>
</tbody>
</table>
Despite the assurances of confidentiality/anonymity, confidentiality was an issue when being asked to provide details on a failure. Individuals seemed reluctant to divulge such sensitive information. Four firms identified that they kill projects prior to launch if they think that they are likely to fail. What is more interesting is that seven of the firms contacted state that they often accept less successful projects, especially if they are for a new customer. As one respondent stated, "in these instances it is often better to provide the product to the new customer, even at a loss, in order to secure future business". Four respondents could not identify a suitable failed product developed during the last five years or had no experience of failed projects since starting at the company. Five respondents simply stated that they "don't have failures", which seems unlikely, but perhaps reflects an unwillingness to discuss negative aspects of their company's performance.

5.8.2.3 Non-Response Error

Non-response error represents "a failure to obtain information from some element of the population that was selected and designated for the sample (Churchill, 1995:661). While literature suggests that the probability of non-random error is higher with a low response rate “a low response rate does not automatically mean that there has been non-response error” (Tull & Hawkins, 1993: 184), rather it is only of interest when the researcher finds a difference between respondents and non-respondents. If this is the case then a researcher can not be confident that the sample findings are representative and, therefore, generalisable to the whole population.

One method of estimating non-response bias is by extrapolation methods which compare respondents who reply readily against those respondents who take longer to reply. This comparison of early and late respondents, as recommended by Armstrong and Overton (1977), is based on a premise that late respondents or respondents to a later wave of mailing are more similar to non-respondents (Aaker and Day, 1990; Leslie, 1972). Wave, refers to the generation of responses through the use of follow-up techniques (Armstrong and Overton, 1977).

For this research, responses gained during the first week (n = 15) were compared with those received after the second follow-up (n = 11) to ensure maximum separation.
Using t-tests for independent samples on key variables, two groups were compared according to firm size, turnover, duration of development projects and level of product technology in order to compare early and late respondents.

However, the firm orientation measures (mass versus niche markets, and market versus technology driven), and the respondent profile measures (job function and management level) used nominal scales, therefore, t-tests were not appropriate for these variables. Therefore, for these variables a chi-square goodness-of fit test was used.

No significant differences were observed at the 5% significance level across all these key variables which provides evidence that non-response bias not a major problem (see Table 5.7 and 5.8).

Table 5.7 - Summary of T-Test Results

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early Respondents</td>
<td>Late Respondents</td>
</tr>
<tr>
<td>Number of Employees</td>
<td>3064.27</td>
<td>6148.18</td>
</tr>
<tr>
<td>Annual Sales</td>
<td>448.88</td>
<td>957.16</td>
</tr>
<tr>
<td>Turnover</td>
<td>1.93</td>
<td>1.91</td>
</tr>
<tr>
<td>Duration</td>
<td>11.47</td>
<td>15.36</td>
</tr>
<tr>
<td>Level of Technology</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.8 - Summary of Chi-Square Results

<table>
<thead>
<tr>
<th>Variables</th>
<th>(\chi^2) Value</th>
<th>DF</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass v Niche</td>
<td>2.101</td>
<td>3</td>
<td>.552</td>
</tr>
<tr>
<td>Market v Technology</td>
<td>.764</td>
<td>2</td>
<td>.683</td>
</tr>
<tr>
<td>Job Function</td>
<td>2.169</td>
<td>4</td>
<td>.705</td>
</tr>
<tr>
<td>Management Level</td>
<td>3.901</td>
<td>3</td>
<td>.272</td>
</tr>
</tbody>
</table>

What is also encouraging is that the only reason provided for eligible respondents not replying was to do with lack of time (see section 5.8.2). This suggests that interest in the topic, or questionnaire length have not influenced the chance of response and provides further evidence to suggest that non-response error is not an issue of concern.
### 5.8.2.4 Item Non-Response

Item non-response is where specific items have not been answered or not been responded to correctly (either on purpose or because of misunderstanding) and can occur for similar reasons to those of sample non-response (Churchill, 1995; Diamantopoulos and Schlegelmilch, 1997).

Data can be missing for a number of reasons, respondents either: 1) forgot to answer; 2) refused to answer; 3) had no opinion/insufficient knowledge; or 4) couldn’t remember. (Diamantopoulos and Schlegelmilch, 1997; Hair et al., 1995). It is up to the researcher to decide why the data is missing, whether the missing data is sufficient to warrant actions and how to deal with it (Diamantopoulos and Schlegelmilch, 1997; Little and Rubin, 1987; Hair et al., 1995).

This decision is partly determined by the statistical analysis that is to follow, as well as theoretical considerations. The analyst must decide whether alternative variables are available and whether these variables represent the intent of the original variable (Hair et al., 1995). It is also important to determine whether the missing data is scattered randomly or whether distinct patterns are identifiable for either cases or variables (Hair et al., 1995). Because, if there are patterns to the missing data then it can be assumed that there is some process in action and that “any statistical results based on the data would be biased to the data process” (Hair et al., 1995: 43).

In the analysis the researcher will be creating summated scales, therefore, it is not too problematic to have a single missing item for a construct as this is not likely to affect the scale average too much. However, what would be problematic would be if a case had large numbers of missing values for a scale (the few remaining items could produce a very biased average), or if all the items were missing (i.e. no average would be possible).

The first thing that can be seen from figure 5.6 is that there are two cases with large numbers of missing data. Cases 19 and 40 had 14 and 17 items missing respectively. 11 of the items from case 19 were from the performance measurement section and case 40 had all the prototyping, tooling, and testing and validation items missing.
There are also three variables with large numbers of missing values. Spend on R&D for both 1995 and 1996 had a very large number of missing items (18 for 1995, 14 for 1996, \( n = 78 \)) and were, therefore, removed. Annual sales turnover for 1995 was also removed on the basis that: 1) it had 19 missing items; and 2) as expected, it was highly correlated with Annual sales turnover for 1996 (\( r = 0.9994, p = 0.000 \)) which had more data available (only 13 missing items).

Once these two cases and the three poorly answered variables are removed there are no more than eight missing items per case. There are no more than five missing items for any of the individual variables and no more than three for any of the variables to be included in the scale constructs. All the missing data now shows a random pattern (Hair et al., 1995).

**Figure 5.6 - Number of Missing Variables Per Case, Prior to Deletion**

![Figure 5.6](image)

**Figure 5.7 - Number of Missing Variables Per Case, After Deletion**

![Figure 5.7](image)
5.9 SUMMARY

This chapter has provided detailed information on the methodology employed to undertake the research. A mail survey was undertaken and a questionnaire developed based on literature and qualitative findings. This was then rigorously pretested using both interviews and two pilot studies. The main study size was 320 (including the 30 firms prenotified using MIRA contacts) and the adjusted response rate was 41.3%. Due to the findings of the comparison of early versus late respondents there is no reason to suspect that non-response error is a problem. Thus, 76 usable questionnaires were available for further analysis, the findings of which are presented in Chapters 6 and 7.
CHAPTER 6

FIRM GENERAL AND NPD CHARACTERISTICS

Another area where ‘averaging’ may have been affecting the c.s.f. identified is through possible moderator variables. A study by Mishra et al. (1996) concludes by suggesting that moderating variables, such as, firm size; orientation and strategy, may have affected the findings of previous studies. Therefore, the chapter that follows aims to determine whether the performance of projects studied have been affected by any of these environmental variables.

First, the researcher analyses the available success measures to determine the most effective performance measure against which the potential moderating variables can be assessed. Then, each of the variables that capture the firms’ general and NPD characteristics are described, followed by a more detailed assessment of their affect on the performance outcome.

6.1 SUCCESS MEASURES

In terms of the dichotomous success/failure category, the sample consists predominantly of data on successful NPD projects, with just under four-fifths of the projects being successes (79.5%, n = 76). As discussed in section 5.8.2.2, (chapter 5) this high ratio of successes to failures is due to firms reluctance to provide details about failures. This small number of projects detailing failures (n = 15) will make any subsequent analysis of the effect of different characteristics on the success/failure category variable more difficult because there will be too few failures. Therefore, an overall success index was also computed (an average of all the success measures).

Table 6.1 shows that the average mean performance was 5.877 (n = 76). The success mean was 6.431 (n = 61) and the failure mean was 3.626 (n = 15).

Table 6.1 - Summary of the Performance Distributions

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate performance</td>
<td>5.877</td>
<td>1.560</td>
<td>1.333</td>
<td>8.944</td>
</tr>
<tr>
<td>Success</td>
<td>6.431</td>
<td>.988</td>
<td>4.667</td>
<td>8.944</td>
</tr>
<tr>
<td>Failure</td>
<td>3.626</td>
<td>1.447</td>
<td>1.333</td>
<td>6.611</td>
</tr>
</tbody>
</table>
However, when an average of all the 18 individual performance measures is calculated, the distribution (see figure 6.1) is found to be reasonably normal, with a kurtosis of .660 and a slight negative skew (-.773) and the one-sample Kolmogorov-Smirnov significance level is large enough that the normality assumption is not unreasonable ($p = 0.347$). Therefore, despite the fact that 79.9% of the sample were ticked as successes and only 20.3% were deemed failures the average performance is 5.88, only 0.88 above the mid-point of the scale.

This is not particularly surprising given the findings of the follow-up to increase the number of failures returned (see Section 5.8.2.2, Chapter 5). Nearly 30% of the firms contacted (seven out of 25) identified that their company often accepted less successful projects and would, therefore, classify them as successes.

**Figure 6.1 - Average Performance Distribution**

![Average Performance Distribution](image)

(SI = Average performance of the project)

The fact that the success index is reasonably normally distributed means that it will be a more useful measure when assessing the effects of the firms general and NPD characteristics on the performance outcome. Therefore, it was decided to use both the categorical success/failure measure and the success index measure to assess the relationship between each of the variables and performance.
6.2 GENERAL FIRM CHARACTERISTICS

6.2.1 FIRM SIZE

This research employed two variables to measure firm size. These were, number of employees and annual sales turnover (£) for 1996. Table 6.2 provides a summary of the two distributions.

The number of full time employees range from only two to 115000, with an average of 6464.75 and standard deviation of 19817.52. Figure 6.2 presents the distribution of full-time employees. 16.9% of the respondents employ less than 100 people and 29.9% of the respondent firms employ more than 1000 workers, of which 13% employ more than 10000 people.

Table 6.2 - Summary of Firm Size Measures

<table>
<thead>
<tr>
<th>Size indicator</th>
<th>Abs. Freq.</th>
<th>Percent</th>
<th>Mean</th>
<th>Std Dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Employees</td>
<td>&lt;100</td>
<td>13</td>
<td>16.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>101-200</td>
<td>10</td>
<td>13.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>201-300</td>
<td>3</td>
<td>3.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>301-400</td>
<td>8</td>
<td>10.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>401-500</td>
<td>2</td>
<td>2.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>501-600</td>
<td>1</td>
<td>1.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>601-700</td>
<td>4</td>
<td>5.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>701-800</td>
<td>3</td>
<td>3.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>801-900</td>
<td>5</td>
<td>6.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>901-1000</td>
<td>3</td>
<td>3.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1001-10000</td>
<td>13</td>
<td>16.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;10000</td>
<td>10</td>
<td>13.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>1</td>
<td>1.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Turnover 95</th>
<th>Abs. Freq.</th>
<th>Percent</th>
<th>Mean</th>
<th>Std Dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>15</td>
<td>19.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11-20</td>
<td>9</td>
<td>11.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-30</td>
<td>8</td>
<td>10.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31-40</td>
<td>5</td>
<td>6.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41-50</td>
<td>1</td>
<td>1.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51-60</td>
<td>4</td>
<td>5.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>61-70</td>
<td>1</td>
<td>1.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>71-80</td>
<td>5</td>
<td>6.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>81-90</td>
<td>4</td>
<td>5.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91-100</td>
<td>4</td>
<td>5.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>101-1000</td>
<td>6</td>
<td>7.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;10000</td>
<td>9</td>
<td>11.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>5</td>
<td>6.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>6464.75</th>
<th>19817.52</th>
<th>2</th>
<th>115000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>608.78</td>
<td>1682.38</td>
<td>.60</td>
<td>7900</td>
</tr>
</tbody>
</table>
In terms of annual sales turnover, 21.1% (n = 76) of the respondents reported sales turnover of 10 million or less; at the other extreme, there are 15 respondents (19.5%) with annual sales turnover of greater than £100 million, of which 11.7% have a turnover greater than £1000 million. Consequently, the mean annual sales turnover is inflated to £608.78 thousand with a standard deviation of 1682.38. Figure 6.3 provides an overview of the 1996 annual sales turnover distribution.

**Figure 6.2 - Distribution of Full Time Employees**

![Graph showing distribution of full time employees.]

**Figure 6.3 - Distribution of Annual Sales Turnover for 1996**

![Graph showing distribution of annual sales turnover.]

Both indicators of firm size are similarly distributed (Figure 6.2 and 6.3) with more respondents in each of the extremes.
In order to identify whether turnover and number of employees are associated with success, two correlations were calculated for annual sales turnover for 1996 and number of employees against the success index. The Pearson correlation, however, was not significant for annual sales turnover (r = .109, p = 0.365) or number of employees (r = 0.1647, p = 0.158).

In terms of the dichotomous success/failure category, two-sample t-tests were undertaken for each of these two firm size measures. Both showed non-significant results (see Table 6.3).

**Table 6.3 - Results of t-tests against Success**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>t-value</th>
<th>df</th>
<th>sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Employees</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Success</td>
<td>5362.93</td>
<td>-.96</td>
<td>73</td>
<td>.339</td>
</tr>
<tr>
<td>Failure</td>
<td>10872.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Sales Turnover</td>
<td>486.85</td>
<td>-1.18</td>
<td>69</td>
<td>.241</td>
</tr>
<tr>
<td></td>
<td>1064.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Therefore, it can be concluded that neither variables are significantly associated with overall performance.

As expected annual sales turnover was highly correlated with the number of full time employees (r = 0.889, p = .000). Therefore, in any further analysis only one of these measures of firm size would be required. Annual sales turnover has been identified as a good surrogate for company resources (e.g. Bonaccorsi, 1992) and will, therefore, be used.

However, because turnover is not normally distributed it is not possible to use it in any further analyses of association as it is. Therefore, it was decided to divide annual sales turnover into three equal groups, small, medium and large. The choice of equal groups was to ensure that no researcher bias was introduced into the decision of what constitutes small, medium and large. Three groups were chosen to ensure that there were enough cases in each group.

Small was identified as less than or equal to 20.0, medium was greater than 20.0 thousand, and large was over 80.0 thousand. Two of the groups had 24 cases and one had 23, n = 71).

This measure will, therefore, be used in any further tests of association against turnover.
6.2.2 PRODUCT SECTORS

The open-ended question about the product type was coded using the standard product indices provided by the SAE (The Engineering Society of Advanced Mobility, Land, Sea, Air and Space) Worldwide Manufacturers’ Directory of Engineered Automotive Products.

The average number of cases per product sector was 3.8 (Product sectors = 20, n = 76). Two of the sectors were not represented: Steering, which tends to include lower technology products that do not require much development, such as columns, rods and horns; and Transaxle components, such as clutches, gears, transmission valves etc., which would be expected to be represented. It is unlikely that steering products would fit into the ‘significant product’ definition (see section 5.2, chapter 5) and this category is, therefore, excluded from the analysis of the product sector findings.

Figure 6.4 - Distribution of Firms

As can be seen from the distribution of cases by product sectors (see figure 6.4) there are more respondents from the mechanical engine components (12%, n = 76); electrical components (12%); body components (9%); and HVAC (Heating,
Ventilation and Air Conditioning) components (9%). However, three of these would be expected to be over represented given that they are three of the largest sub-sections within the automotive components industry (see Table 6.4).

Table 6.4 shows the approximate number of companies identified by the SAE directory to be operating in each of the 19 sectors in Europe against the number of respondents for each of the sectors. From the chi square distribution it was determined that for the sample to be representative the test value of $\chi^2$, with 18 degrees of freedom, at a significance level of 5% is 28.869.

For the null hypothesis to be true, i.e. that the observed sample is representative of the overall population of European firms, the actual $\chi^2$ must be below this critical value.

The actual total is 34.651 which means that sample is not representative of the population.

<table>
<thead>
<tr>
<th></th>
<th>Total for Europe</th>
<th>Sample</th>
<th>(O - E)$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Observed</td>
<td>Expected</td>
</tr>
<tr>
<td>Body</td>
<td>120</td>
<td>7</td>
<td>8.19</td>
</tr>
<tr>
<td>Braking</td>
<td>25</td>
<td>2</td>
<td>1.70</td>
</tr>
<tr>
<td>Drivetrain</td>
<td>45</td>
<td>3</td>
<td>3.07</td>
</tr>
<tr>
<td>Electrical</td>
<td>130</td>
<td>9</td>
<td>8.86</td>
</tr>
<tr>
<td>Electronic Engine</td>
<td>50</td>
<td>4</td>
<td>3.41</td>
</tr>
<tr>
<td>Exhaust</td>
<td>40</td>
<td>1</td>
<td>2.73</td>
</tr>
<tr>
<td>Fuel</td>
<td>50</td>
<td>3</td>
<td>3.41</td>
</tr>
<tr>
<td>HVAC</td>
<td>30</td>
<td>7</td>
<td>2.04</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>10</td>
<td>1</td>
<td>0.68</td>
</tr>
<tr>
<td>Mechanical Engine</td>
<td>170</td>
<td>9</td>
<td>11.59</td>
</tr>
<tr>
<td>Multi-Purpose</td>
<td>180</td>
<td>4</td>
<td>12.27</td>
</tr>
<tr>
<td>Passenger</td>
<td>15</td>
<td>2</td>
<td>1.02</td>
</tr>
<tr>
<td>Seating</td>
<td>25</td>
<td>3</td>
<td>1.70</td>
</tr>
<tr>
<td>S/W &amp; H/W</td>
<td>10</td>
<td>1</td>
<td>0.68</td>
</tr>
<tr>
<td>Suspension</td>
<td>45</td>
<td>4</td>
<td>3.07</td>
</tr>
<tr>
<td>Transaxle</td>
<td>80</td>
<td>0</td>
<td>5.45</td>
</tr>
<tr>
<td>Trim</td>
<td>35</td>
<td>1</td>
<td>2.39</td>
</tr>
<tr>
<td>Wheel/Tyre</td>
<td>30</td>
<td>5</td>
<td>2.04</td>
</tr>
<tr>
<td>Accessories</td>
<td>40</td>
<td>5</td>
<td>2.73</td>
</tr>
<tr>
<td>Total</td>
<td>1115</td>
<td>76</td>
<td>76</td>
</tr>
</tbody>
</table>
However, this total is close to the critical value of 28.869 (difference = 5.782) considering under representation of multi-purpose companies (which is not surprising given that many of the products included in this sector are adhesives, bearings, belts, bolts, cables, hoses, nuts, pins, tape and washers which are low technology products not requiring significant development). Only a few of the products are sufficiently technological, such as gaskets and gears, to have been appropriate. Therefore, a large number of the firms in this product sector would not have been suitable respondents, which would significantly reduced the error term for the multi-purpose sector (see table 6.4).

The fact that some groups only have one response makes it impossible to compare the significance for either success or failure.

6.3 FIRM STRATEGY

This section looks at the distributions of the two measures of firm strategy, firm orientation and segmentation strategies.

6.3.1 MARKET VERSUS TECHNOLOGY DRIVEN STRATEGY

Market orientated companies that strive for competitive advantage perform better (Hooley and Lynch, 1985; Jobber, 1998; Narver and Slater, 1990). Cooper (1985) identifies that a balanced strategy is most strongly linked to performance.

Therefore, the results shown in table 6.5 and figure 6.5 are encouraging. Automotive component suppliers seem to have understood the importance of being market focused as well as having a technologically innovative product. 30.3% of the respondents identified their firm as being market focused and 63.2% of the respondents suggested that they used a balanced strategy. Only five of the respondents (6.6%) reported being technologically focused and driven. These findings contrast quite strongly with those of Griffin and Page (1993) who surveyed 50 practitioners attending two PDMA conferences in 1991 and found a much more even spread across the categories. 36% of these respondents identified themselves as being market-driven, 38% as using a balanced strategy and 26% stated that their company was technology driven.

However, it could also be that the respondents to this study have learned to say the 'right' things.
Table 6.5 - Summary of Market Versus Technology Driven Strategy

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Number of Respondents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Driven</td>
<td>23</td>
<td>30.3</td>
</tr>
<tr>
<td>Combination</td>
<td>48</td>
<td>63.2</td>
</tr>
<tr>
<td>Technology Driven</td>
<td>5</td>
<td>6.6</td>
</tr>
</tbody>
</table>

To determine whether these three strategies were related to the success/failure categorical choice, a chi-square ($\chi^2$) test of independence was conducted. To determine whether the strategies were related to the overall success index a one-way ANOVA test of association was performed.

The results from the chi square test show that there is no significant relationship between the strategies and the success/failure categorical selection ($\chi^2 = 2.22$, df = 2, $p = 0.330$).

The one-way ANOVA test against the success index also found no significant differences between the groups at the 5% level.

Figure 6.5 - Pie Chart of Market Versus Technology Strategy

6.3.2 MASS VERSUS NICHE MARKETS

Table 6.6 and figure 6.6 shows that the three segmentation groups are approximately even. This equal proportion of firms aiming at niche markets could be explained by the competitiveness of the automotive components industry and the nature of the customers with which they deal. Many firms have identified that niche markets can be profitable too.
Kotler et al. (1996) identify that successful NPD becomes even more difficult as greater competition leads to increasing market fragmentation. In highly competitive environments companies must aim at smaller market segments to avoid competition (Jobber, 1998). This is especially true for smaller firms because of their limited resources.

Therefore, a Kruskal-Wallis one-way ANOVA test was undertaken to determine whether the segmentation strategies are related to firm size, using the three annual sales turnover groups. This was not found to be significant at the 5% level ($\chi^2 = 4.389$, df = 2, p = 0.111). Therefore, it is accepted that, there is no difference between the three firm sizes in terms of segmentation strategies used.

In order to determine whether these segmentation strategies are linked to competitiveness the researcher calculated an average competitiveness index for the eight competitiveness variables in the questionnaire. This index was normally distributed with a mean of 5.7 and a standard deviation of 1.67 (see figure 6.7).
Therefore, to test the null hypothesis that there is no difference in the competitiveness means for the three strategies a one-way ANOVA was undertaken. However, no two groups are significantly different at the 5% level.

A one-way ANOVA test was also employed to test the relationship between the three strategy types and success. Again, there were no significant differences in the groups at the 5% level.

A chi square test for independence was conducted to test for a relationship between the segmentation strategies and the success/failure category. This analysis showed no significant relationship between segmentation strategies and success ($\chi^2 = 2.22004$, df = 2, p = 0.330).

The findings from section 6.3.1 and section 6.3.2 provide evidence to suggest that the two firm orientation variables do not discriminate well between overall success and failure.

6.4 RESPONDENT PROFILE

Table 6.7 shows the basic characteristics of the respondents according to job function and level of management.
Table 6.7 - Summary of Respondent Characteristics

<table>
<thead>
<tr>
<th>Job Function</th>
<th>Number of Respondents</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D/Development</td>
<td>20</td>
<td>26.3</td>
</tr>
<tr>
<td>Design</td>
<td>11</td>
<td>14.5</td>
</tr>
<tr>
<td>Marketing</td>
<td>23</td>
<td>30.3</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>3</td>
<td>3.9</td>
</tr>
<tr>
<td>Other</td>
<td>19</td>
<td>25.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Management Level</th>
<th>Number of Respondents</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director</td>
<td>33</td>
<td>43.4</td>
</tr>
<tr>
<td>Senior Manager</td>
<td>26</td>
<td>34.2</td>
</tr>
<tr>
<td>Functional Manager</td>
<td>8</td>
<td>10.5</td>
</tr>
<tr>
<td>Product Manager</td>
<td>6</td>
<td>7.9</td>
</tr>
<tr>
<td>No Management</td>
<td>2</td>
<td>2.6</td>
</tr>
<tr>
<td>Responsibility (Missing)</td>
<td>1</td>
<td>1.3</td>
</tr>
</tbody>
</table>

6.4.1 JOB FUNCTION

As can be seen from table 6.7 and figure 6.8, there is a relatively even split between R&D/Development; Marketing and Other (26.3%, 30.3%, 25.0% respectively, n =76), accounting for 81.6% of the respondents. Eleven of the respondents work for design function (14.5%) and three from manufacturing (3.9%).

Other is made up of six general management respondents: six that identified themselves as covering all aspects of management; four sales representatives; two respondents from finance; and one from the quality function.

These findings are fairly similar to Griffin and Page (1996) sample demographic information, although they did not have a separate design category. If design is included with the R&D category, over two-fifths of the respondents are from R&D/Design (40.8%).
6.4.2 MANAGEMENT LEVEL

In terms of the management level of respondents, just under half of the respondents are directors (43.4%, n = 76). The next largest category is Senior Managers which account for 34.2% of the respondents. The remaining 22.4% is made up of functional managers, product managers and those with no management responsibility (eight, six and two respondents respectively). These results can be seen in table 6.7 and figure 6.9.

As the cover letter asked for the person 'who had a responsibility for NPD' within the organisation, this large number of director level respondents was interesting. This could mean that: 1) a high level of importance is placed on product development in this industry; 2) respondents were not the most appropriate people to complete the questionnaire, however, this would still show that they understand the importance of NPD to their business; 3) the management level was linked to firm size and the higher level respondents were all from smaller firms.

To test whether the management level was linked to firm size, first, the researcher looked at management level broken down into job titles, to see exactly what each of these management levels included (see Table 6.8).
Table 6.8 - Job Titles by Management Levels

<table>
<thead>
<tr>
<th>Management Level</th>
<th>Job Title</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director</td>
<td>Chief Executive</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Managing Director</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>UK Director</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Director &amp; General Manager</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Sales and/or Marketing</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Engineering/Technical Director</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>R&amp;D Director</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Quality Director</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>4</td>
</tr>
<tr>
<td>Senior Manager</td>
<td>General/Business Manager</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Sales Manager</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Marketing Manager</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Commercial Manager</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Production Manager</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Technical Manager</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Design Manager</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>5</td>
</tr>
<tr>
<td>Functional Manager</td>
<td>Marketing Manager</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Executive/Chief Engineer</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Project Finance Manager</td>
<td>2</td>
</tr>
<tr>
<td>Product Manager</td>
<td>Account Manager</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Business Development Manager</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Principal/Technical Engineer</td>
<td>4</td>
</tr>
<tr>
<td>No Management Resp.</td>
<td>Vehicle Test Engineer</td>
<td>2</td>
</tr>
</tbody>
</table>
A Kruskal-Wallis one-way ANOVA test was employed in order to see whether these management level categories correlate with firm size, using the small, medium and large categories of firm size. i.e. were more of the Director level respondents from smaller firms, who would be likely to have a responsibility for everything? Conversely, were the lower level managers from the very large organisations? A significant difference was obtained (\( \chi^2 = 8.773 \), df = 4, p = 0.067) and the mean ranks (see table 6.9) show that more of the directors were from smaller firms. Therefore, the researcher can be more confident that the large numbers of high level managers does not necessarily mean that they were not the appropriate respondents.

**Table 6.9 - Kruskal-Wallis One-way ANOVA for Management Level**

<table>
<thead>
<tr>
<th>Management Level</th>
<th>Mean Rank</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director</td>
<td>31.09</td>
<td>33</td>
</tr>
<tr>
<td>Senior Manager</td>
<td>39.73</td>
<td>26</td>
</tr>
<tr>
<td>Functional Manager</td>
<td>49.44</td>
<td>8</td>
</tr>
<tr>
<td>Product Manager</td>
<td>45.25</td>
<td>6</td>
</tr>
<tr>
<td>No Management Responsibility</td>
<td>62.00</td>
<td>2</td>
</tr>
</tbody>
</table>

The chi square test for independence between management level and the success/failure category did not produce a significant result (\( \chi^2 = 1.93036 \), df = 4, p = 0.74857).

**6.5 NPD CHARACTERISTICS**

**6.5.1 DURATION OF THE PROJECT**

Table 6.10 provides a summary of the project duration’s in months and figure 6.10 shows the distribution of the project duration’s.

The average duration for the development projects was 26.3 months (approximately equal to 2 years, 2 months). This proves the findings of recent studies which identify that lead times are shortening. A study by Clark, Chew and Fujimoto identified that the average car project used to be 46 months for Japanese VM’s and 60 months (5 years) for the US and European VM’s and component suppliers have to develop their products in close association with the VM’s (Clark et al., 1987; Clark, 1989).
However, products need to be brought to market much more quickly in the future (Daniels, 1996), therefore, as VM's lead times shorten, component suppliers are having to speed up their development processes in line with the improvements being made by the VM’s.

**Table 6.10 - Summary of Project Duration in Months**

<table>
<thead>
<tr>
<th>Duration of the Project (months)</th>
<th>Value</th>
<th>Abs. Freq.</th>
<th>Percent</th>
<th>Mean</th>
<th>Std Dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;= 6</td>
<td>6</td>
<td>7.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 - 12</td>
<td>9</td>
<td>11.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 - 18</td>
<td>5</td>
<td>6.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 - 24</td>
<td>16</td>
<td>21.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 - 30</td>
<td>8</td>
<td>10.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31 - 36</td>
<td>16</td>
<td>21.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37 - 42</td>
<td>3</td>
<td>3.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43 - 48</td>
<td>6</td>
<td>7.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>49 - 54</td>
<td>1</td>
<td>1.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55 - 60</td>
<td>1</td>
<td>1.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>5</td>
<td>6.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 6.10 - Distribution of Project Duration in Months**

The peaks correspond to large groups at 24 months (12 cases) and 36 months (16 cases). These peaks could suggest that respondents were rounding their estimates of the length of the project duration to whole years, possibly due to problems with recall.
In order to determine whether project duration was correlated with success, i.e. did less successful development projects take significantly longer than their more successful counterparts, a pearson correlation was calculated. This showed no significant relationship between project duration and overall success ($r = 0.648, p = 0.591$).

A t-test of categorical success/failure against project duration showed no significant differences in the means between success and failure ($t = 0.42, df = 69, p = 0.675$).

### 6.5.2 SOURCE OF NEW PRODUCT IDEA

Respondents were asked to identify which sources of the new product idea were relevant to the particular development project and were able to tick more than one option.

Table 6.11 shows that 56.6% of the respondents suggested that the new product idea came, at least partly, from inside the company ($n = 76$). Almost as many quoted the customer as a source of the new product idea (55.3%, $n = 76$). Competitors provided the source of the new product idea for 23.7% of the projects and suppliers 13.2% of the ideas.

<table>
<thead>
<tr>
<th>Source</th>
<th>Number of Respondents</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal</td>
<td>43</td>
<td>56.6</td>
</tr>
<tr>
<td>Customers</td>
<td>42</td>
<td>55.3</td>
</tr>
<tr>
<td>Competitors</td>
<td>18</td>
<td>23.7</td>
</tr>
<tr>
<td>Suppliers</td>
<td>10</td>
<td>13.2</td>
</tr>
<tr>
<td>Other</td>
<td>15</td>
<td>19.7</td>
</tr>
</tbody>
</table>

The other category included: legislation (60%, $n = 15$); Universities (13%); and one respondent each for R&D establishment/consultancy firm and the MOD (0.7% each). Two respondents choosing 'other' did not provide any details.

Separate Mann-Whitney U tests were conducted for the relationship between each of the sources of the new product idea and the two success groups.

It can be seen from table 6.12 that there is no statistically significant difference when the successful projects are compared against the failed projects for customers,
competitors, suppliers, and others as sources of the new product idea. However, the internal group did show a significant result \((p = 0.044)\). The projects that were from an internal idea source were associated with a successful project outcome.

**Table 6.12 - Mann-Whitney U Tests of the Source of the New Product Idea**

<table>
<thead>
<tr>
<th>Source</th>
<th>Mean Rank</th>
<th>N</th>
<th>Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal</td>
<td>Idea Source</td>
<td>41.58</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Not a source</td>
<td>34.48</td>
<td>33</td>
</tr>
<tr>
<td>Customers</td>
<td>Idea Source</td>
<td>36.95</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Not a source</td>
<td>40.41</td>
<td>34</td>
</tr>
<tr>
<td>Competitors</td>
<td>Idea Source</td>
<td>41.78</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Not a source</td>
<td>37.48</td>
<td>58</td>
</tr>
<tr>
<td>Suppliers</td>
<td>Idea Source</td>
<td>42.20</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Not a source</td>
<td>37.94</td>
<td>66</td>
</tr>
<tr>
<td>Other</td>
<td>Idea Source</td>
<td>43.47</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Not a source</td>
<td>37.28</td>
<td>61</td>
</tr>
</tbody>
</table>

Separate two-sample t-tests were performed to test the relationship between the source of the new product idea and the overall success index (see table 6.13).

**Table 6.13 - T-test for Source of New Product Idea**

<table>
<thead>
<tr>
<th>Source</th>
<th>Mean Success</th>
<th>t value</th>
<th>df</th>
<th>sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal</td>
<td>Yes</td>
<td>6.243</td>
<td>2.40</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>5.401</td>
<td>74</td>
<td>0.885</td>
</tr>
<tr>
<td>Customer</td>
<td>Yes</td>
<td>5.901</td>
<td>0.14</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>5.848</td>
<td>74</td>
<td>0.313</td>
</tr>
<tr>
<td>Competitor</td>
<td>Yes</td>
<td>6.213</td>
<td>1.05</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>5.773</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Supplier</td>
<td>Yes</td>
<td>6.344</td>
<td>1.02</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>5.806</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Yes</td>
<td>6.262</td>
<td>1.07</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>5.783</td>
<td>74</td>
<td></td>
</tr>
</tbody>
</table>

The mean success index for projects with an internal source was 6.243 against those which weren't developed from an internal idea source \((mean = 5.401)\). This difference was significant at the 5% level \((t = 2.40, df = 74, p = 0.019)\). This, again identifies that internal sources are more likely to lead to a successful project outcome.
No other sources of the new product idea were found to be significant, therefore, it can be concluded that there is no relationship between the external sources of the new product ideas and success.

6.5.3 JOINT VENTURE

Table 6.14 summarises the responses to whether the project was developed as a joint venture, and if so, who with. More than half of the projects were developed as joint ventures (63.2%, n = 76), showing how important joint ventures are to the automotive components industry.

Overall, just under one-third of the projects were undertaken as a joint venture with customers (32.9%, n = 76). Both customers and suppliers were involved in 17 of the projects (22.4%) and 8% of the projects were undertaken as joint ventures with just suppliers. No projects were developed as joint ventures with competitors. Just under one-third (30%, n = 76) of the products were not developed as joint ventures.

<table>
<thead>
<tr>
<th>Joint Venture</th>
<th>Number of Respondents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers</td>
<td>25</td>
<td>32.9</td>
</tr>
<tr>
<td>Competitors</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Suppliers</td>
<td>6</td>
<td>7.9</td>
</tr>
<tr>
<td>Customers and Suppliers</td>
<td>17</td>
<td>22.4</td>
</tr>
<tr>
<td>Not Applicable</td>
<td>22</td>
<td>28.9</td>
</tr>
<tr>
<td>Missing</td>
<td>6</td>
<td>7.9</td>
</tr>
</tbody>
</table>

A k-sample chi square test is employed to test whether there is a relationship between the choice of joint venture partners and success or failure. This revealed that there is no significant difference for any of the joint venture partnerships ($\chi^2 = 3.52298$, df = 3, p = 0.318).

One-way ANOVA of the 5 different joint venture groups against the overall success index also shows that no two groups were significantly different. Therefore, it can be concluded that whether the project was undertaken as a joint venture or not does not discriminate well between success and failure.
6.5.4 HIGH VERSUS LOW TECHNOLOGY

Table 6.15 examines the level of technology of the products developed and figure 6.11 shows the distribution of the responses to the product technology level.

The majority of the products were of average or just above average technology (categories 5 and 6). 32.9% were average (category = 5, n = 76) and 18.4% (category = 6) were just above average. There were no very low technology products (categories 0 and 1) which is not surprising given that the unit of analysis was "a major system/sub-assembly development project by an automotive component supplier", as defined by Lamming (1993).

Table 6.15 - Technology Level of the Product Developed

<table>
<thead>
<tr>
<th>Products’ Technology Level</th>
<th>Value</th>
<th>Abs. Freq.</th>
<th>%</th>
<th>Mean</th>
<th>Std Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>1.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>8</td>
<td>10.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>2</td>
<td>2.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>25</td>
<td>32.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>14</td>
<td>18.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>6</td>
<td>7.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>9</td>
<td>11.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>7</td>
<td>9.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>3</td>
<td>3.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td></td>
<td>1</td>
<td>1.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The mean level of technology is 6.0, with a standard deviation of 1.924 and the Kolmogorov-Smirnov test for normality produces a significant result (p = 0.019), therefore, the distribution cannot be assumed to be normal.

A Mann-Whitney U test was employed to test whether there was a difference in the technology level between successful projects and failed projects. The mean ranks were 38.76 and 34.68 for success and failure respectively and no significant difference was observed (p = 0.517).
In terms of overall success a one-way ANOVA test was used to identify whether there are any significant differences between the performance outcomes for each of the technology levels. Table 6.16 shows that it is not possible to reject the null hypothesis that there are no differences between the means of the nine technology level groups, because the F ratio is close to one and its significance is 0.138.

**Table 6.16 - One-way ANOVA of Technology Levels**

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>F Ratio</th>
<th>F Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>8</td>
<td>27.8003</td>
<td>3.4750</td>
<td>1.6140</td>
<td>.1377</td>
</tr>
<tr>
<td>Within Groups</td>
<td>66</td>
<td>142.1060</td>
<td>2.1531</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>74</td>
<td>169.9063</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Therefore, it is accepted that the level of technology is not associated with the performance of the projects.
6.6 SUMMARY

Overall, success is reasonably normally distributed with a mean of 5.88 and a standard deviation of 1.560, which was interesting, given that 79.9% of the sample were deemed to be successes and only 20.3% failures. However, looking at the average performance results, it can be seen that the dichotomous success/failure measure alone does not provide a true reflection of the variability of project success.

As expected, annual sales turnover and employment are highly correlated ($r = 0.889, p = 0.000$). However, neither show significant correlations with the success index or the individual s/f category.

The sample is not representative of the overall population of European automotive component suppliers at the 5% level. However, it is not too far off, especially when the percentage of relevant products in the under represented sectors is taken into account. What is also encouraging is that it provides a good distribution of all but two of the relevant product sectors.

In terms of firm strategy, companies seem to understand the importance of having a market focus, backed by good technology i.e. a balanced strategy (63.2%, $n = 76$). However, no association with overall success was detected. This is different to the findings of Cooper 1985 who found that a balanced strategy is most strongly linked to performance.

The three product segmentation strategies were equally popular. Many more firms than expected focus most of their products on niche markets, possibly because of the highly competitive nature of the automotive industry.

Again, no significant differences were found between the three segmentation strategies and success.

In terms of respondents, there were a high percentage of R&D/Development/Design respondents (40.8%), as well as a large number of marketing respondents (30.3%) which was consistent with the findings of Griffin and Page (1993, 1996). There were a large number of Director level respondents (43.4%) and senior managers (34.2%) and there was a significant link between the management level and firm size.
There were more directors from smaller firms and more lower level managers from larger firms suggesting that these are likely to be appropriate respondents.

This large percentage of high level managers also shows the importance placed on NPD in this industry.

In terms of NPD characteristics, average project duration was 26.3 months (approximately 2 years, 2 months). This is shorter than the findings of previous automotive industry studies (Clark et al, 1987; Clark, 1989) probably because of the VM’s need to reduce lead times. Therefore, this shortening of lead times, added to the pressure being placed on automotive component suppliers to innovate (Simonian, 1998) means that firms need to learn which are the most important activities and which are less important so that time is not wasted on activities that will not improve the products chances of success.

Only internal sources of the new product idea were found to be significantly related to performance, suggesting that internal sources are more likely to lead to a successful project outcome. None of the external sources produced a significant result.

More than half the projects were developed as joint ventures with others in the value chain (63.2%). This high proportion shows the importance of relationships with customers and suppliers in the automotive components industry. However, this variable did not discriminate well between success and failure.
CHAPTER 7
MODEL OPERATIONALISATION

In this chapter the model of the antecedents of new product performance, presented in Chapter 4, is operationalised and tested.

The chapter begins with a discussion about the difference between ‘effect’ and ‘causal’ indicators, and how these two alternative models affect the analysis to follow. Then, an overview of the analysis procedures is presented. Following this, the scale development procedures that have been used to operationalise the ten independent constructs (Table 5.1) and project performance are discussed. Coefficient alpha is used to assess the reliability of the scale items, then factor analysis is used to assess unidimensionality. Then summated scales are produced for each of the model constructs. Next, an outlier analysis and multicollinearity checks are undertaken. Finally, multiple regression analysis is used to estimate the various linkages in the model for each of the dimensions of success found. A total of four regression models are developed, one for each dimension of success identified.

7.1 ‘EFFECT’ VERSUS ‘CAUSAL’ INDICATORS

Prior to using scale development techniques it is first necessary for the researcher to determine the applicability of using such conventional methods. Bollen and Lennox (1991) identify that the procedures used to operationalise scale constructs are qualified by the direction of the relationship between the indicators and the underlying construct. They propose that some items do not conform to the classical models, which view scale items/indicators as dependent on a latent variable (Bollen, 1984). These have been termed, ‘effect indicators’ (Bollen and Lennox, 1991). The ‘effect indicator’ model is shown in Figure 7.1. Scales that conform to this model are, therefore, testable using the traditional criteria for selection of “good” measures, such as, correlations and coefficient alpha reliability (see section 7.2.1)
An example would be market assessment, i.e. if market assessment had been undertaken very well for a project then it would be expected that the project would score highly on all items relating to market assessment.

The alternative model that they propose is a 'causal indicator' model in which the indicators determine the latent variable, as in Figure 7.2. In this model it would not be possible to establish whether the indicators would be correlated with all of the other indicators, because the indicator items relate to independent aspects which when combined make up the overall construct. Therefore, causal indicators of the same concept can have positive, negative or no correlation at all.

An example would be the construct of product advantage, which can be achieved by a variety of means, i.e. a product could have differentiation through any or all of the following: the physical product, and/or the service, and/or the people, and/or the company brand/image.

If dealt with as if it were an 'effect indicator' model it could produce low correlations, low reliabilities and would certainly not be unidimensional. Therefore, in order to assess validity of causal indicators the researcher must examine other variables that effect the latent constructs.
Bollen and Lennox (1991:312) state that “Traditional measures of reliability and the examination of the correlation matrix of indicators are so ingrained that researchers have failed to realize that these are not appropriate under all situations”. Researchers should, therefore, specify which model relates their indicators to latent variables and should not confine themselves to the unidimensional classical test model.

In terms of the model proposed (figure 4.1, Chapter 4 and section 5.5.3, chapter 5), 8 of the 11 scales are expected to follow the classical test theory, and are, therefore, ‘effect indicators’. However, the very nature of the product advantage and non-product advantage constructs, which identify competitive advantage, precludes the likelihood of them being effect indicators. Kotler et al. (1996:401) discuss the achievement of differentiation through delivering products that provide customers with the greatest value, i.e. “being different in a way that customers want”, and suggests that differentiation can be achieved through the physical product, the service provided, the people who provide the service and even from the image of the company or brand. Jobber (1998) suggests firms can obtain a competitive advantage through differentiation of their product and through cost leadership and firms can focus on one unique selling point (USP) or more than one of these differentiating factors. Therefore, product advantage and non-product advantage are likely to follow the ‘causal indicator’ model proposed by Bollen and Lennox (1991), where the indicators determine the latent variable. However, within this causal indicator construct, each of the aspects of differential advantage have been assessed using multiple items, and will, therefore, be evaluated separately as individual ‘effect’ (see figure 7.3). This argument also holds true for the items measuring success, since it is widely accepted that dimensions of success exist.
### Table 7.1 - Overview of the Steps in the Analysis

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Purpose</th>
<th>Selected References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cronbach's Coefficient alphas</td>
<td>To assess the reliability of the scales</td>
<td>Nunnally and Bernstein (1994); DeVellis (1991); Spector (1992)</td>
</tr>
<tr>
<td>2. Principal Component analysis</td>
<td>To assess the unidimensionality of the scale</td>
<td>Gerbing and Anderson (1988); Churchill (1995); Cortina (1993)</td>
</tr>
<tr>
<td>3. Factor analysis of success measures</td>
<td>To confirm previously identified measures</td>
<td>Cooper and Kleinschmidt (1987c); Griffin and Page (1993); Hultink et al (1997); Hart (1992)</td>
</tr>
<tr>
<td>4. Form summated scales</td>
<td>To overcome the inherent limitations of single item measures</td>
<td>Churchill (1979); Gerbing and Anderson (1988)</td>
</tr>
<tr>
<td>6. Outlier analysis and multicollinearity checks</td>
<td>To make the data set most representative of the actual population</td>
<td>Hair et al (1995); Norusis (1997); Speed (1994)</td>
</tr>
<tr>
<td>7. Multiple regression analysis for each of the identified success dimensions</td>
<td>To determine the critical success factors (c.s.f.) for each dimension</td>
<td>Fox (1991); Hair et al (1995); Kleinbaum et al (1988); Speed (1994)</td>
</tr>
</tbody>
</table>

#### 7.2 SCALE DEVELOPMENT

All the variables in the study model (Chapter 4, figure 4.1) represent constructs which “are broad in scope and not easily assessed with a single question” (Spector, 1992:4). Therefore, each of these variables were operationalised by a summated rating scale using the statements in the questionnaire (Chapter 5, section 5.5.3 and Appendix 5.9) following the advice given in the methodology literature (Churchill, 1995; DeVellis, 1991; Spector, 1992).

While many items were developed specifically for this study other measurement items were derived from existing, well-validated scales. Therefore, where scales have been used before, the findings of this study will be compared with the findings of these previous studies by Cooper and Kleinschmidt (1995), Song and Parry (1996) and Hultink et al. (1997). Where they could be improved by adding or removing items, this will be discussed.
7.2.1 ITEM ANALYSIS

The methodology literature provides advice on the process of scale development (Churchill, 1995; DeVellis, 1991; Spector, 1992). This discussion will only cover the steps associated with conducting the item analysis and the evaluation of the validity and reliability of the scales as discussed in section 5.5.4.

Firstly, the literature suggests splitting the sample, with one set of cases serving as the primary development sample, and the other being used for cross-validation of the findings. However, whilst splitting the sample can provide valuable information about the stability of the scale, the 76 cases available was not thought “sufficiently” large for this to be done (DeVellis, 1991: 90). Therefore, the process of item evaluation and scale construction was undertaken on the whole sample.

Next, the performance of the individual items comprising each scale were examined. The purpose of item analysis is to identify the items that do not form internally consistent scales, because this implies that they are not measuring the construct of interest. These should then be removed (Spector, 1992). Items which had been negatively worded during the questionnaire design, to avoid repetitive answering, were reverse scored. If the reverse scoring of items did not eliminate the negative correlations, the items were deleted (DeVellis, 1991).

Next, the items were assessed using histograms and the correlation matrix to identify “poor” items, i.e. those items with “non central mean, poor variability, negative correlations among items, low item-scale correlations and weak inter-item correlations” (DeVellis, 1991: 83). Items with low item-correlations were eliminated one at a time and the scale statistics recalculated prior to any more purification. This recalculation is necessary because the removal of an item can significantly influence the item scale correlations of the remaining items (DeVellis, 1991).

The idea of this stage in the scale development procedure is to assess the reliability of the scales. Reliability is defined as: “the extent that [measurements] are repeatable” (Nunnally and Bernstein, 1994: 248), i.e. that results are similar from occasion to occasion (Churchill, 1995). Reliability depends on how much of the differences in the scores are attributable to random errors and how much is measurement error (Nunnally and Bernstein, 1994; Churchill, 1995).

---

3. Issues relating to developing a pool of items, providing response choices, writing instructions and pretesting the items were covered in the methodology chapter (Chapter 5).
7.2.2 COEFFICIENT ALPHA

Coefficient alpha (Cronbach, 1951) is one method of assessing the reliability of a scale. It provides an indication of the scale item scores attributable to the true score of the latent construct, where scale variance is broken down into true variation in the underlying construct and error. The other main method for assessing internal consistency is the split-half method. Split-half is assessed by splitting all the items in a construct into two groups, because equally reliable effect indicators of a unidimensional construct are interchangeable (Bollen and Lennox, 1991). Therefore, subsets of the possible items that are affected by the latent construct should be equally able to measure the latent construct. The correlation between these two parts is taken as its’ reliability estimate. However, this method has been criticised because the split is made arbitrarily and can give different results depending upon how it is split (Peterson, 1994). Coefficient alpha overcomes this by looking at all the items simultaneously.

Nunnally (1978) suggests a value of 0.70 as a lower acceptable boundary for alpha, however, scales published with lower alphas are not unusual. DeVellis (1991:85) suggests that below 0.60 is unacceptable, between 0.70 and 0.80 is respectable, between 0.80 and 0.90 is very good and much above 0.90 the researcher should consider shortening the scale. However, the researcher must also bear in mind when interpreting alpha that, alpha is a direct function of the number of items and the extent of the covariation among scale items (DeVellis, 1991; Spector, 1992; Green et al., 1977), and that the relationship between the number of items and alpha is curvilinear (Komorita and Graham, 1965). One problem is that most recent studies have implied that a given level of alpha, usually greater than 0.70, is adequate, without comparing it with the number of items in the scale (Cortina, 1993). Cortina (1993) provides an example which compares the meaning of standardised alpha values of 0.80 for scales made up of three and ten items. For the three item scale the average inter-item correlation is 0.57 and for the ten items this average inter-item correlation is only 0.28, a difference of 0.29. Researchers must base their decision on whether an alpha value is reliable on: the actual alpha value, the number of items in the scale, and the decision that is to be made (Cortina, 1993).

A second issues with alpha is that it should not be taken as an indication of unidimensionality (Cortina, 1993). A composite score for a scale is only meaningful if the scale is ‘acceptably’ unidimensional (Gerbng and Anderson, 1988) and as Green et al. (1977) identify, internal
consistency is a necessary but not sufficient condition for unidimensionality. Unidimensionality is the existence of a single trait or construct underlying a set of measures (Hattie, 1985; McDonald, 1981). Some authors fail to make a distinction between internal consistency and homogeneity and while it may be suggested that multi-dimensionality is irrelevant if a test has a good alpha, because it is free of error associated with the use of different items, Cortina (1993) argues that this does not mean that the total score has a straightforward/unambiguous interpretation. He goes on to state that it does not say anything about the extent to which the dimensions are measuring the construct that they are intended to measure, i.e. the test would be known to measure something consistently, but what that was would still be unknown. Bollen and Lennox (1991) also suggest that forcing effect indicators of distinct dimensions into a unidimensional model is not an adequate solution.

Therefore, literature suggests that prior to assessing the reliability of the composite scores the unidimensionality of the scale must be established using factor analysis (Gerbing and Anderson, 1988). However, when factor analysis is used before purification, researchers have a tendency to produce more dimensions than can actually be conceptualised (Churchill, 1979). Therefore, for this study, the author ran exploratory factor analysis in a confirmatory fashion (Churchill, 1995; Cortina, 1993). First, an iterative process of calculating coefficient alpha for each conceptualised scale was undertaken, eliminating poor items until a satisfactory coefficient was achieved. Then the researcher used factor analysis to identify the principal components of the scale in order to confirm whether the constructs were unidimensional. If second factors were found, any items uniquely loading on this second factor were deleted to produce a one factor solution and the scale coefficient alpha recalculated.

### 7.2.3 FACTOR ANALYSIS PROCEDURES

For the Factor Analysis the author used principal component factor analysis which aims to transform a set of interrelated variables into a set of unrelated linear combinations of these variables (Churchill, 1995; Cortina, 1993).

Factor analysis aids scale development by quantifying how much of the total variation in the entire set of items can be accounted for by each of the items found (DeVellis, 1991).

There are several guidelines as to how many factors to extract (Stewart, 1981). The two most popular are; Kaiser’s eigenvalue rule (e.g. Nunnally and Bernstein, 1994) which is also

---

175
known as the latent roots criterion, which, generally, should be greater than 1 (Churchill, 1995:972); and Cattell's (1965) scree test, which entails plotting the amount of variance explained by each successive factor. While there is no one correct method of determining the number of factors, the norm of using eigen values of 1 or more is generally accepted. However, where eigen values of just below 1 were found during the analysis, these were also investigated to check whether they provided any important information.

Sometimes the interpretation of factors can be difficult, especially when variables load on more than one factor. Rotating the axes can facilitate the interpretation of factors (Churchill, 1995). Varimax rotation maximises the variance of squared loadings and is the most common orthogonal rotation method (DeVellis, 1991; Churchill, 1995) and was, therefore, used.

This choice of principal component factor analysis with varimax rotation is consistent with previous significant work (Cooper and de Brentani, 1984 and Zirger and Maidique, 1990). The next section reports the choice of items for each of the constructs, showing the item-total correlations and the reliability of the scales by calculating coefficient alphas for each of the multi-item scales.

7.3 MODEL OPERATIONALISATION

7.3.1 PRODUCT ADVANTAGE

The concept of product advantage was identified in the conceptualisation of this study (Chapter 4) to be more likely to fit the 'causal indicator' model (Bollen and Lennox, 1991), and, thus, would not be expected to be unidimensional. Therefore, it would not have been appropriate to calculate the coefficient alpha for the items. This is different to previous studies who quote alpha values for product advantage (Cooper and Kleinschmidt, 1995; Song and Parry, 1996). Cooper and Kleinschmidt (1995:318) state that "for each key constructs, such as product advantage, an index was computed by taking the average across its constituent variables. The constructs tended to be strong ones, with high internal consistencies (coefficient alpha of > 0.70 on 10 of the 12 constructs)". Song and Parry (1996) also report inter-item correlations and a coefficient alpha of 0.88 for product advantage.

However, groups of items within the construct relate to each of the product differentiation indicators identified to be important to the automotive components industry, which follow the classical 'effect indicator' model (see figure 7.3).
A principal component factor analysis was used to confirm the dimensions expected from the conceptualisation. This produced a three factor solution. Rotating the matrix produced three distinct and uniquely loading factors (see table 7.2).

Table 7.2 - Rotated Factor Matrix for Product Advantage Items

<table>
<thead>
<tr>
<th>Factor</th>
<th>Eigen value</th>
<th>% var.</th>
<th>Cum %</th>
<th>Variables loading on factor</th>
<th>Variable loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1 - Uniqueness</td>
<td>3.089</td>
<td>28.1</td>
<td>28.1</td>
<td>Unique features; Highly innovative product; Improved customer operation; Permitted customer to do something new</td>
<td>.67536 .79059 .63240 .80664</td>
</tr>
<tr>
<td>Factor 2 - Product performance</td>
<td>2.021</td>
<td>18.4</td>
<td>46.5</td>
<td>Meeting customer needs; Superior product quality; Superior technical performance</td>
<td>.60731 .68401 .79488</td>
</tr>
<tr>
<td>Factor 3 - Cost leadership</td>
<td>1.377</td>
<td>12.5</td>
<td>59.0</td>
<td>Lower priced product; Better value for money</td>
<td>.77656 .81169</td>
</tr>
</tbody>
</table>

Factor 1 includes items about unique features, having a highly innovative product, and whether the product improved the customers operation or permitted the customer to do something not previously possible. This factor was named “uniqueness” based on the literature (Kotler et al., 1996:96) and accounted for 28.1% of the variation among the items.
Factor 2 included items about meeting customer needs, meeting quality, and technical performance of the product. This was named “product performance” and accounted for 18.4% of the variance.

Factor 3 included two items, whether the product was priced lower and whether the product was better value for money and is, therefore, about cost leadership (Jobber, 1998:501). This factor explained 12.5% of the variance.

Items 5 and 7 (i.e. the product used completely new technology and the benefits of this product were highly visible/easy to communicate to customers) did not load on any of the identified factors and were, therefore, not used.

Because such clear factors that could be easily named emerged from the factor analysis (and fitted with the conceptualisation, section 4.2.3, Chapter 4) coefficient alphas were calculated to see if these items could be used separately to measure different aspects of product advantage. They would provide more informative findings than an overall index/aggregate of their scores i.e. overall product advantage. This is especially true when it is likely that different types of product advantage may affect the different performance measures.

The “uniqueness” items produced a coefficient alpha value of 0.75 which was “respectable” (DeVellis, 1991 : 85) and no improvement was possible by removing any items (Table 7.3).

**Table 7.3 - Characteristics of the Uniqueness Scale**

<table>
<thead>
<tr>
<th>Uniqueness Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.55)</td>
<td>0.75</td>
</tr>
<tr>
<td>This product offered some unique features or attributes to the customer</td>
<td>0.56</td>
<td></td>
</tr>
<tr>
<td>This product was highly innovative, new to the market</td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>This product improved the customers’ operation (product and/or process)</td>
<td>0.47</td>
<td></td>
</tr>
<tr>
<td>This product permitted the customer to do something he could not presently do with what was available</td>
<td>0.54</td>
<td></td>
</tr>
</tbody>
</table>

The alpha value for the three items of “performance” was 0.54 (Table 7.4) which is below the suggested minimum, however there are only three items in the scale and average inter-item correlation is 0.36, which is reasonable.
The reliability for the two ‘cost’ items was 0.66 (Table 7.5), which is again lower than the minimum recommended alpha values. However, as discussed in section 7.2.2, the fact that there are only two items in the scale and their average inter-item correlation is 0.50, which is reasonably high, suggests that the scale reliability is acceptable (Cortina, 1993).

**Table 7.4 - Characteristics of the Product Performance Scale**

<table>
<thead>
<tr>
<th>Performance Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.36)</td>
<td>0.54</td>
</tr>
<tr>
<td>This product met customers’ needs better than competing products</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>This product was superior in terms of product quality relative to competitors</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>This product had superior technical performance</td>
<td>0.47</td>
<td></td>
</tr>
</tbody>
</table>

**Table 7.5 - Characteristics of the Cost Scale**

<table>
<thead>
<tr>
<th>Cost Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.50)</td>
<td>0.66</td>
</tr>
<tr>
<td>This product was priced lower than competitors' product</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>This product provided the customer with better value for money relative to alternative products</td>
<td>0.50</td>
<td></td>
</tr>
</tbody>
</table>

Another reason for including these two scales, despite their lower alpha values is that there is a need to publish less significant, as well as non significant results, so that knowledge of the principal drivers of new product performance may progress beyond an exploratory, descriptive nature (Montoya-Weiss and Calantone, 1994). Some previous less integrated work has removed lower correlated variable constructs for the sake of parsimony and higher alpha scores, however, established models produced from these highly correlated but narrow heterogeneous dimensions have not been well accepted by practitioners (de Brentani, 1986; Montoya-Weiss and Calanatone, 1994; Wind and Mahajan, 1988), and may provide some explanation as to why large numbers of products are still failing (Urban and Hauser, 1993). Therefore, a more comprehensive approach is warranted that does include even the lower correlated constructs, if they provide a more detailed explanation of the environment.
7.3.2 NON-PRODUCT ADVANTAGE

There were four items in the non-product advantage scale. Factor analysis provided a two factor solution, factor 1 included items three and four and explained 43.4% of the variance and was based on advantage through distribution. This produced an alpha value of 0.71 (Table 7.6).

Table 7.6 - Characteristics of the Distribution Scale

<table>
<thead>
<tr>
<th>Distribution Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.55)</td>
<td>0.71</td>
</tr>
<tr>
<td>This product had an advantage via product availability/delivery</td>
<td>0.55</td>
<td></td>
</tr>
<tr>
<td>This product had an advantage through flexibility of production volumes</td>
<td>0.55</td>
<td></td>
</tr>
</tbody>
</table>

However, the second factor made no conceptual sense, including items about technical service and the company or brand image. These items had low communalities in the factor analysis and produced a low alpha value of 0.37 and were, therefore, not used.

Therefore, it was decided that the three scales identified for product advantage and the one for non-product advantage should be included separately in the model operationalisation because they provide more detailed information on the types of competitive advantage that firms should be aiming to achieve. An overall measure of product advantage is inherently more difficult to interpret because practitioners can not be sure what type of differential advantage is most appropriate for any particular situation.

7.3.3 PROJECT ORGANISATION

The item pool was made up of eight statements under project organisation and three statements under project planning. Item one was a “poor” item with a non-central mean and poor variability (DeVellis, 1991:83) and was, therefore, removed.

The coefficient alpha for all the other variables was 0.83. Item seven (authority of the project manager) had a very low item-total correlation (0.18) and was, therefore, removed and the reliability recalculated. This produced an alpha value of 0.84. Item three (top management
support) also had a very low item-total correlation (0.26) and was also removed, producing an alpha value of 0.85. The alpha value was recalculated twice more after having removed items four and five which had item-total correlations of 0.30 and 0.36 respectively, producing an alpha value of 0.88 (see Table 7.7). No more items were removed because only marginal gains would have been produced. The remaining items produced a single factor solution explaining 59.3% of the variance.

**Table 7.7 Characteristics of the Project Organisation Scale**

<table>
<thead>
<tr>
<th>Project Organisation Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.67)</td>
<td>0.88</td>
</tr>
<tr>
<td>There was a core team, who were responsible for the project from beginning to end</td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>The internal communications within the project team were excellent</td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>The cost of the project was closely monitored</td>
<td>0.42</td>
<td></td>
</tr>
<tr>
<td>The development process was highly formalised</td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>A detailed timetable for the subsequent product development stages had been established</td>
<td>0.79</td>
<td></td>
</tr>
<tr>
<td>Team member responsibilities were well defined prior to development</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>Detailed milestones/goals for measuring the performance and progress for each stage of the development process had been established</td>
<td>0.75</td>
<td></td>
</tr>
</tbody>
</table>

**7.3.4 MARKET ASSESSMENT**

Of the eight items of market assessment none were "poor" items, therefore, the reliability was calculated for all eight items, produced an alpha value of 0.78. Item four (customers price sensitivity) was found to have a very low item-total correlation and was removed. The reliability was recalculated and the alpha value was 0.80, which is "very good" (DeVellis, 1991:85). Further purification was not necessary because no improvement could be made to this already high reliability (Table 7.8) and the factor analysis solution showed a single factor accounting for 45.8% of the variance.

Song and Parry (1996) identify an alpha value of 0.84 for both of their market assessment scales, market information and proficiency of market research.
Table 7.8 - Characteristics of the Market Assessment Scale

<table>
<thead>
<tr>
<th>Market Assessment Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.53)</td>
<td>0.80</td>
</tr>
<tr>
<td>We understood all our potential customers’ needs, wants and specifications for this</td>
<td>0.47</td>
<td></td>
</tr>
<tr>
<td>product</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We carried out ‘end user’ customer clinics to identify their potential needs and wants</td>
<td>0.48</td>
<td></td>
</tr>
<tr>
<td>We understood the market characteristics and trends for this product well</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>We knew our competitors well (e.g. their products, pricing, strategies, and strengths)</td>
<td>0.52</td>
<td></td>
</tr>
<tr>
<td>We carried out a full examination and benchmarking exercise of competitors products</td>
<td>0.64</td>
<td></td>
</tr>
<tr>
<td>The size of our potential market for this product was unknown</td>
<td>0.41</td>
<td></td>
</tr>
<tr>
<td>We knew exactly when competitor's products were going to be launched</td>
<td>0.53</td>
<td></td>
</tr>
</tbody>
</table>

7.3.5 TECHNICAL ASSESSMENT

This scale was made up of eight items. The reliability of all the technical assessment items produced an alpha value of 0.84 and further purification would only have produced marginal gains to this already high reliability. However, when running the principal component factor analysis to confirm unidimensionality a two factor solution was obtained (Table 7.9).

Table 7.9 - Rotated Factor Matrix for Technical Assessment Items

<table>
<thead>
<tr>
<th>Factor</th>
<th>Eigen value</th>
<th>% var.</th>
<th>Cum %</th>
<th>Variables loading on factor</th>
<th>Variable loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1</td>
<td>3.810</td>
<td>47.6</td>
<td>47.6</td>
<td>Understood technology well</td>
<td>.60567</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Good knowledge of manufacturing costs</td>
<td>.74577</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Conducted engineering, technical and manufacturing assessments</td>
<td>.70659</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Determined feasibility</td>
<td>.79544</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Identified all sourcing alternatives</td>
<td>.52640</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Assessed potential environmental risks</td>
<td>.68197</td>
</tr>
<tr>
<td>Factor 2</td>
<td>1.097</td>
<td>13.7</td>
<td>61.3</td>
<td>Clear specifications and features</td>
<td>.87456</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Technical problems clear</td>
<td>.84919</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Understood technology well</td>
<td>.53018</td>
</tr>
</tbody>
</table>
Items one and two only load onto the second factor, and item three loads onto both factors. Therefore, items one and two were removed and a second factor analysis run. This time only a single factor was obtained, explaining 53.2% of the variance.

The reliability for items three to eight was recalculated, which produced an alpha value of 0.82, a reduction of only 0.02, which could not be improved by the removal of any other items (Table 7.10).

Song and Parry (1996) report a coefficient alpha value of 0.81 for a technological information scale which included five of the original eight items, including items one and two which were not found to be measuring the same construct in this study.

Table 7.10 - Characteristics of the Technical Assessment Scale

<table>
<thead>
<tr>
<th>Technical Assessment Items</th>
<th>Corrected Inter-Item Correlations</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.58)</td>
<td>0.82</td>
</tr>
<tr>
<td>We knew and understood the technology behind this product well</td>
<td>0.63</td>
<td></td>
</tr>
<tr>
<td>We had a good knowledge of the costs involved in manufacturing this product</td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>We had conducted preliminary engineering, technical and manufacturing assessments</td>
<td>0.63</td>
<td></td>
</tr>
<tr>
<td>The feasibility of developing and manufacturing a product with these features had been evaluated</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>We had identified all possible sourcing alternatives for component parts</td>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>No assessment was carried out on the potential environmental risks (emissions, materials, waste, packaging, process)</td>
<td>0.44</td>
<td></td>
</tr>
</tbody>
</table>

7.3.6 CONCEPT DEVELOPMENT AND EVALUATION

There were six items measuring concept generation and screening. Item five had a non-central mean and small variance and was therefore removed. The reliability analysis of the other five items produced an alpha value of 0.81 and the factor analysis produced a single factor solution explaining 58.4% of the variance. Given the satisfactory quality of the five items the scale required no purification (Table 7.11).

This scale had been used before by Song and Parry (1996) who report an alpha value of 0.81. However, their scale also included the item 'determining the feasibility of developing and
manufacturing a product with these features'. This item, when included in the scale, did increase alpha to 0.85, which is unsurprising given that coefficient alpha is affected by the number of items in the scale (DeVellis, 1991; Spector, 1992). However, the questionnaire development for this study had identified that this item was related to the technical assessment of the project, rather than concept development and evaluation, and was, therefore, included in the technical assessment construct instead.

Table 7.11 - Characteristics of Concept Development and Evaluation

<table>
<thead>
<tr>
<th>Concept Development and Evaluation Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.61)</td>
<td>0.81</td>
</tr>
<tr>
<td>We produced a comprehensive product design specification prior to development</td>
<td>0.53</td>
<td></td>
</tr>
<tr>
<td>We carried out extensive modelling and prototyping before we had an agreed product design specification</td>
<td>0.46</td>
<td></td>
</tr>
<tr>
<td>The product concept was translated into business terms (such as market share, profitability, etc.)</td>
<td>0.58</td>
<td></td>
</tr>
<tr>
<td>Key business implications of the product concept and its development had been identified</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>Overall, the initial screening of the product idea was carried out well</td>
<td>0.76</td>
<td></td>
</tr>
</tbody>
</table>

7.3.7 DEVELOPMENT PROGRAMME

Of the twelve Development Programme items, two items had poor variability and non-central means. Items five and eleven were, therefore, removed. The computed alpha value for the remaining ten items was 0.85 which is “very good” (DeVellis, 1991: 85). Item three had a very low item-total correlation and was deleted, which produced a recalculated alpha value of 0.87. This could not have been improved by the removal of any other items.

The exploratory factor analysis, however, identified a two factor solution which, when rotated showed items 1,2,4 and 12 solely loading on the first factor and 6,7,8 and 10 loading on the second factor (Table 7.12). Item nine loaded on both factors. This proves that the construct is not unidimensional
Table 7.12 - Rotated Factor Matrix for Development Programme Items

<table>
<thead>
<tr>
<th>Factor</th>
<th>Eigen value</th>
<th>% var.</th>
<th>Cum %</th>
<th>Variables loading on factor</th>
<th>Variable loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1 - Design</td>
<td>4.481</td>
<td>49.8</td>
<td>49.8</td>
<td>Performed engineering analysis well</td>
<td>.83289</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Prepared design FMEA well</td>
<td>.86008</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Extensive analytic/predictive work</td>
<td>.81193</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Developed full test and validation plan</td>
<td>.54649</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reassessed FMEA at end</td>
<td>.69119</td>
</tr>
<tr>
<td>Factor 2 - Co-ordination process</td>
<td>1.364</td>
<td>15.2</td>
<td>64.9</td>
<td>PDS regularly reviewed</td>
<td>.61042</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PDS regularly updated</td>
<td>.51924</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Manufacturing process developed in parallel</td>
<td>.87174</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Developed full test and validation plan</td>
<td>.51031</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Production sources and assembly techniques decisions made in parallel with design</td>
<td>.84397</td>
</tr>
</tbody>
</table>

When the author attempted to name these items it was immediately obvious that the items loading on factor one were about product design and the items loading on factor two were all about the parallel, co-ordination processes (Clark, Chew and Fujimoto, 1987). Therefore, the reliabilities for each of these constructs were calculated producing alpha values of 0.85 and 0.80 respectively (Tables 7.13 and 7.14 respectively). No further improvements could be made to either of the scales.

Item nine, (A full test and validation plan was developed at this stage) was removed because it loaded on both factors and would, therefore, increase the likelihood of multicollinearity during the next stage of the analysis (see section 7.4).

Table 7.13 - Characteristics of Design Scale

<table>
<thead>
<tr>
<th>Design Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.70)</td>
<td>0.85</td>
</tr>
<tr>
<td>We performed the engineering analysis well</td>
<td>0.72</td>
<td></td>
</tr>
<tr>
<td>We prepared the design FMEAs well</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Extensive up-front analytic and predictive work was carried out prior to prototyping</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>The FMEA was thoroughly reassessed at the end of the development process</td>
<td>0.59</td>
<td></td>
</tr>
</tbody>
</table>
Table 7.14 - Characteristics of Co-ordination Scale

<table>
<thead>
<tr>
<th>Co-ordination Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.61)</td>
<td>0.80</td>
</tr>
<tr>
<td>The product design specification or outline of requirements was regularly reviewed</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>as the design developed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The product design specification or outline of requirements was regularly updated</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>as the design developed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The manufacturing process was developed in parallel with the product</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>Decisions about production sources and production assembly techniques went on in</td>
<td>0.54</td>
<td></td>
</tr>
<tr>
<td>parallel with design</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7.3.8 PRODUCT TESTING AND VALIDATION

There were six items relating to the testing and validation of the product. Items one and six were removed prior to calculating alpha because they had non-central means and low variance. The alpha value for the remaining four items was 0.70, which could not be improved by the removal of any other items (Table 7.15). The factor solution produced a single factor accounting for 55.9% of the covariation among the items.

Table 7.15 - Characteristics of the Product Testing and Validation Scale

<table>
<thead>
<tr>
<th>Product Testing and Validation Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.51)</td>
<td>0.70</td>
</tr>
<tr>
<td>We interpreted the findings from the in-house trials and incorporated them into the</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>product design and commercialisation plans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We carried out extensive product/component bench testing to determine performance</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>against specifications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We carried out extensive in-vehicle testing</td>
<td>0.47</td>
<td></td>
</tr>
<tr>
<td>Customers were highly involved with the product testing</td>
<td>0.43</td>
<td></td>
</tr>
</tbody>
</table>

7.3.9 PROCESS TESTING AND VALIDATION

The reliability analysis of these four items produced a coefficient alpha of 0.57. Item four had a very low item-total correlation of 0.09 and was, therefore, removed and the alpha value recalculated. The alpha value for the remaining three items was 0.71 and could not be
improved by removing any further items (see table 7.16). The exploratory factor analysis confirmed the unidimensionality of the construct. The single factor solution explained 64% of the variance.

**Table 7.16 - Characteristics of the Process Testing and Validation Scale**

<table>
<thead>
<tr>
<th>Process Testing and Validation Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha $\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.53)</td>
<td>0.71</td>
</tr>
<tr>
<td>We carried out the validation of off-tool production well</td>
<td>0.48</td>
<td></td>
</tr>
<tr>
<td>We ran capability studies to optimise the production process for this product</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>We carried out employee training well</td>
<td>0.62</td>
<td></td>
</tr>
</tbody>
</table>

**7.3.10 MARKET LAUNCH**

Item three of the four market launch items had a poor mean and variance and was, therefore, removed prior to calculating the alpha value. The alpha value for remaining three items was 0.18, with item four having a negative item correlation. Item four was removed and the coefficient alpha was then calculated for the remaining two market launch items, producing an alpha value of 0.89 (see table 7.17), and these produced a single factor solution explaining 89.9% of the variance.

Song and Parry (1996) report an alpha value of 0.88 for their market launch proficiency scale.

**Table 7.17 - Characteristics of the Market Launch Scale**

<table>
<thead>
<tr>
<th>Market Launch Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha $\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.80)</td>
<td>0.89</td>
</tr>
<tr>
<td>We satisfied our customers delivery schedule with respect to timing</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>We satisfied customers quality requirements</td>
<td>0.80</td>
<td></td>
</tr>
</tbody>
</table>

**7.3.11 COMPANY CHARACTERISTICS**

Of the seven items used in the questionnaire, item seven was removed because it exhibited non-central mean and low variance. The reliability analysis of the remaining six items
produced an alpha value of 0.87 (Table 7.18). All items were strongly correlated with each other. A factor analysis produced a single factor solution explaining 61.6% of the variability. Further purification was not undertaken because no improvements could be made to this already high reliability.

Table 7.18 - Characteristics of the Company Characteristics Scale

<table>
<thead>
<tr>
<th>Company Characteristics Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.68)</td>
<td>0.87</td>
</tr>
<tr>
<td>financial resources</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>R&amp;D/product development skills</td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td>manufacturing / production resources</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>management skills</td>
<td>0.76</td>
<td></td>
</tr>
<tr>
<td>market research skills</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>engineering skills</td>
<td>0.56</td>
<td></td>
</tr>
</tbody>
</table>

7.3.12 MARKET POTENTIAL

The three items measuring of market potential produced an alpha value of 0.69, which is acceptable given that there are only three items and their average inter-item correlation is 0.51 (see table 7.19). This could not be improved by removing any other items and produced a single factor solution explaining 62.1% of the variance.

Song and Parry (1996) reported an alpha value of 0.65 for these three market potential items.

Table 7.19 - Characteristics of the Market Potential Scale

<table>
<thead>
<tr>
<th>Market Potential Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.51)</td>
<td>0.69</td>
</tr>
<tr>
<td>Potential customers had a great need for this class of product</td>
<td>0.49</td>
<td></td>
</tr>
<tr>
<td>The market for this product was growing very quickly</td>
<td>0.53</td>
<td></td>
</tr>
<tr>
<td>The market size (either existing or potential) for this product was large</td>
<td>0.50</td>
<td></td>
</tr>
</tbody>
</table>

7.3.13 MARKET COMPETITIVENESS

The reliability of the eight market competitiveness items produced an alpha value of 0.72 which is “respectable” (DeVellis, 1991:85). However, the exploratory factor analysis identified a two factor solution. Items six, eight, nine and ten loaded on factor one and items
four, five and eleven on factor two. Item seven loaded on both factors. The author removed items four, five and eleven, which were obviously measuring something different, to produce a single factor solution which explained 46.4% of the variation. The recalculated alpha value for items six to ten was 0.70 and further purification would not have improved the alpha value (Table 7.20).

Song and Parry (1996) reported an alpha value of 0.68 for their market competitiveness scale which included all the initial items except 'there were barriers to entry for new competition' which was identified from literature (Chapter 2) and the exploratory study (Chapter 3).

Table 7.20 - Characteristics of the Market Competitiveness Scale

<table>
<thead>
<tr>
<th>Market Competitiveness Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.46)</td>
<td>0.70</td>
</tr>
<tr>
<td>Potential customers for this product were very loyal to competitors' products</td>
<td>0.39</td>
<td></td>
</tr>
<tr>
<td>There were many competitors in this market</td>
<td>0.47</td>
<td></td>
</tr>
<tr>
<td>There was a strong, dominant competitor in this market</td>
<td>0.48</td>
<td></td>
</tr>
<tr>
<td>Potential customers for this product were very satisfied with competitors' products</td>
<td>0.58</td>
<td></td>
</tr>
<tr>
<td>There were barriers to entry for new competition</td>
<td>0.38</td>
<td></td>
</tr>
</tbody>
</table>

7.3.14 DIMENSIONS OF PERFORMANCE

A study by Hultink et al. (1997) reports alpha values for three orthogonal dimensions of success which had been previously identified in a study by Griffin and Page (1993).

They report alpha values of 0.95 for financial performance; 0.95 for customer-determined success, and 0.89 for product-level performance. They also report an alpha value of 0.97 for combining all the items into an overall measure of success. However, given that scales should be unidimensional, this must not be appropriate if it is accepted that the items belong to different dimensions.

When the same items from this study are chosen for each of the dimensions, alpha values of 0.91 for financial success, 0.79 for customer-determined success, and 0.78 for product-level success are found (Table 7.21), two of which are obviously much lower than reported in the study by Hultink et al. (1997).
Table 7.21 - Comparison of Alpha Values for Performance Dimensions

<table>
<thead>
<tr>
<th></th>
<th>Present Study</th>
<th>Hultink et al.,</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\alpha$</td>
<td>$\alpha$</td>
</tr>
<tr>
<td>Financial Success</td>
<td>0.91</td>
<td>0.95</td>
</tr>
<tr>
<td>Customer-determined</td>
<td>0.79</td>
<td>0.95</td>
</tr>
<tr>
<td>Success</td>
<td>0.78</td>
<td>0.89</td>
</tr>
</tbody>
</table>

The author had also included a ‘window of opportunity’ success dimension which has been used in numerous previous studies (Cooper and Kleinschmidt, 1987b, 1987c; Song and Parry, 1996). The alpha value for these two window of opportunity items was 0.86. Song and Parry (1996) report an alpha value of 0.91 for these same two items (see table 7.22).

Table 7.22 - Comparison of Alpha Values for ‘Window of Opportunity’ Dimension

<table>
<thead>
<tr>
<th></th>
<th>Song and Parry</th>
<th>Present Study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corrected Item - Total Correlation</td>
<td>Alpha $\alpha$</td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------</td>
<td>---------------</td>
</tr>
<tr>
<td>new product category</td>
<td>0.83</td>
<td>0.91</td>
</tr>
<tr>
<td>new market</td>
<td>0.83</td>
<td>0.75</td>
</tr>
</tbody>
</table>

However, when the author ran exploratory factor analysis to confirm the unidimensionality of these four scales the results for two of the proposed dimensions were not encouraging.

The four financial items produced a single factor solution explaining 78.9% of the variation. The window of opportunity dimension also produced a single factor solution explaining 87.7% of the variation.

However, the customer-determined success measures produced a two factor solution with items five, six and seven loading onto factor one and items eight and nine uniquely loading onto factor two and explaining 54.5% and 29.9% of the variance respectively. The coefficient alphas for these two factors were 0.86 and 0.92.

The product-level items also produced a two factor solution with 16,17 and 18 loading on one factor which explained 42.6% of the variance and items 11, 12 and 13 loading on factor two and explaining 22.6%.
Therefore, the author decided to look at an overall factor solution for all the performance items to try to determine if there were six independent factors of success (including the window of opportunity dimension), or whether the items grouped in some other way. The principal component factor analysis of the 18 items produced a five factor solution which explained 77.7% of the variance. Table 7.23 shows the results from the rotated factor matrix.

Table 7.23 - Results from the Rotated Factor Matrix for Performance Items

<table>
<thead>
<tr>
<th>Factor</th>
<th>Eigen value</th>
<th>% var.</th>
<th>Cum %</th>
<th>Variables loading on factor</th>
<th>Variable loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1 - Financial 1</td>
<td>6.947</td>
<td>38.6</td>
<td>38.6</td>
<td>Company’s profit levels</td>
<td>.75772</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Margin goals</td>
<td>.78614</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Break-even time</td>
<td>.83694</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IRR/ROI</td>
<td>.89294</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Revenue goals</td>
<td>.80668</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sales volume goals</td>
<td>.50847</td>
</tr>
<tr>
<td>Factor 2 - Customer</td>
<td>2.850</td>
<td>15.8</td>
<td>54.4</td>
<td>Customer acceptance</td>
<td>.77463</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Customer satisfaction</td>
<td>.84672</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reject levels</td>
<td>.58242</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Warranty levels</td>
<td>.64572</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Performance specifications</td>
<td>.78668</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Technological success</td>
<td>.62428</td>
</tr>
<tr>
<td>Factor 3 - Product</td>
<td>1.808</td>
<td>10.0</td>
<td>64.4</td>
<td>Within budget constraints</td>
<td>.82472</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ready ahead of time</td>
<td>.81227</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Launched on time</td>
<td>.70410</td>
</tr>
<tr>
<td>Factor 4 - Financial 2</td>
<td>1.322</td>
<td>7.3</td>
<td>71.8</td>
<td>Market share goals</td>
<td>.77274</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sales volume goals</td>
<td>.72099</td>
</tr>
<tr>
<td>Factor 5 - Window of opportunity</td>
<td>1.050</td>
<td>5.8</td>
<td>77.7</td>
<td>Technological success</td>
<td>.53358</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>New product category</td>
<td>.88109</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>New market opportunity</td>
<td>.72078</td>
</tr>
</tbody>
</table>

The first factor is, obviously, still a financial performance dimension, but also includes measures of revenue and sales volume goals. While these have been found to be part of a customer-based measure in recent studies (Griffin and Page, 1993; Hultink et al., 1997) prior to this they have been listed as financial measures (Hart, 1993; Craig and Hart, 1993) and
have been used by Cooper (1984), Cooper and Kleinschmidt (1987b, 1987d), Hart and Service (1988), Rothwell et al. (1974) and Ayal and Raban (1990).

The second factor includes six items, customer acceptance and satisfaction, two measures of quality (reject and warranty) and whether the product was a technological success and is, therefore, about customer-based success. Factor three was a product-level measure, including items about budget constraints, whether the product was ready ahead of time and whether it was launched on time. Factor four has two items, market share and sales volume (which also loaded on factor one) and also captures aspects of financial performance. Factor five was the ‘window of opportunity’ factor but item 13 ‘whether the product was a technological success’ also loaded on the factor, although not as strongly.

Item 13 (technical success) had been expected to be a product-based performance measure and did not fit conceptually with either of the factors upon which it loaded. It was, therefore, not used.

A further factor analysis was then run for items one to seven. The researcher also included item six in the financial performance factor, because, despite the fact that it had loaded onto a separate factor, this is where it made the most conceptual sense. This produced a single factor solution explaining 69.4% of the variation. The reliability analysis produced an alpha value of 0.92 and further purification would only have produced marginal gains to this highly reliable scale and all items were highly correlated with each other (Table 7.24).

Table 7.24 - Characteristics of the Financial Performance Scale

<table>
<thead>
<tr>
<th>Financial Performance Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.76)</td>
<td>0.92</td>
</tr>
<tr>
<td>The project exceeded company's profit levels</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>The project exceeded margin goals</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>The project exceeded break-even time</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>The project exceeded Internal Rate of Return or Return on</td>
<td>0.76</td>
<td></td>
</tr>
<tr>
<td>Investment goals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The project exceeded revenue goals</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>The project exceeded market share goals</td>
<td>0.60</td>
<td></td>
</tr>
<tr>
<td>The project exceeded sales volume goals (units not revenue)</td>
<td>0.72</td>
<td></td>
</tr>
</tbody>
</table>
Factor analysis was run for items eight to twelve, which produced a single factor, accounting for 62.2% of the variation between items. The reliability of these items was also acceptable, producing an alpha value of 0.85 (see table 7.25). No further purification was necessary because no improvement in the alpha value could have been made by the removal of any of the items.

### Table 7.25 - Characteristics of the Customer-Based Success Scale

<table>
<thead>
<tr>
<th>Customer-Based Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.66)</td>
<td>0.85</td>
</tr>
<tr>
<td>The project exceeded the targets of customer acceptance</td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td>The project exceeded the targets of customer satisfaction</td>
<td>0.79</td>
<td></td>
</tr>
<tr>
<td>The project met acceptable reject levels</td>
<td>0.64</td>
<td></td>
</tr>
<tr>
<td>The project met acceptable warranty levels</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>The product exceeded the performance specifications</td>
<td>0.55</td>
<td></td>
</tr>
</tbody>
</table>

Items 14 and 15 produced a single factor solution explaining 87.7% of the variation and as has already been discussed earlier, these two items produced an alpha value of 0.86 (Table 7.22).

Items 16-18 produced a single factor solution for product-level success which had an alpha value of 0.77 (Table 7.26). This could not be improved by the removal of any of the items.

### Table 7.26 - Characteristics of the Project-Level Success Scale

<table>
<thead>
<tr>
<th>Project-Level Items</th>
<th>Corrected Inter-Item Correlation</th>
<th>alpha α</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Inter-Item Correlations)</td>
<td>(0.60)</td>
<td>0.77</td>
</tr>
<tr>
<td>The new product was developed within the budget constraints</td>
<td>0.58</td>
<td></td>
</tr>
<tr>
<td>The new product was ready ahead of time</td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td>The new product was launched on time</td>
<td>0.55</td>
<td></td>
</tr>
</tbody>
</table>

### 7.3.15 SUMMARY

The scale development procedures produced 20 scales from the eleven constructs evaluated. The extra scales identified during the scale development were the four performance measures (financial, customer-based, product-based and window of opportunity), three measures of product advantage (uniqueness, performance, and cost), and two development measures.
The construct reliabilities ranged from 0.54 to 0.92. All but three were in the respectable range (0.70 and above) suggested by the literature (Nunnally and Bernstein, 1994; Peter, 1979; DeVellis, 1991; Spector, 1992) and eleven constructs had reliability coefficients that met, or exceeded 0.80. Of the three lower alpha values, two had alphas between 0.60 and 0.70 which DeVellis states are “acceptable” (1991:85) and the final alpha of 0.54 was thought to be reasonable given that there were only two items. Table 7.27 reports the coefficient alphas for each of these 20 constructs.

Table 7.27 - Coefficient Alphas for the Developed Scales

<table>
<thead>
<tr>
<th>Construct</th>
<th>Study Alphas</th>
<th>Previous Study Alphas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniqueness Advantage</td>
<td>0.75</td>
<td>combination</td>
</tr>
<tr>
<td>Performance Advantage</td>
<td>0.54</td>
<td>} of 1st three scales - 0.88</td>
</tr>
<tr>
<td>Cost Advantage</td>
<td>0.66</td>
<td>N/A</td>
</tr>
<tr>
<td>Delivery Advantage</td>
<td>0.71</td>
<td>N/A</td>
</tr>
<tr>
<td>Project Organisation</td>
<td>0.88</td>
<td>N/A</td>
</tr>
<tr>
<td>Market Assessment</td>
<td>0.80</td>
<td>0.84</td>
</tr>
<tr>
<td>Technical Assessment</td>
<td>0.82</td>
<td>0.81</td>
</tr>
<tr>
<td>Concept Development and Evaluation</td>
<td>0.81</td>
<td>0.81</td>
</tr>
<tr>
<td>Design</td>
<td>0.85</td>
<td>N/A</td>
</tr>
<tr>
<td>Co-ordination Process</td>
<td>0.80</td>
<td>N/A</td>
</tr>
<tr>
<td>Product Testing and Validation</td>
<td>0.70</td>
<td>combination</td>
</tr>
<tr>
<td>Process Testing and Validation</td>
<td>0.71</td>
<td>two scales - 0.83</td>
</tr>
<tr>
<td>Market Launch</td>
<td>0.89</td>
<td>0.88</td>
</tr>
<tr>
<td>Company Characteristics</td>
<td>0.87</td>
<td>Marketing and technical synergy 0.97 and 0.95</td>
</tr>
<tr>
<td>Market Potential</td>
<td>0.69</td>
<td>0.65</td>
</tr>
<tr>
<td>Market Competitiveness</td>
<td>0.70</td>
<td>0.68</td>
</tr>
<tr>
<td>Financial Success</td>
<td>0.92</td>
<td>N/A</td>
</tr>
<tr>
<td>Customer-based Success</td>
<td>0.85</td>
<td>N/A</td>
</tr>
<tr>
<td>Product-based Success</td>
<td>0.77</td>
<td>N/A</td>
</tr>
<tr>
<td>Window of Opportunity</td>
<td>0.86</td>
<td>0.91</td>
</tr>
</tbody>
</table>

(* Used different measures than the present study)
7.3.16 VALIDATION OF THE SCALES

However, consistency is necessary but not sufficient for validity (Nunnally and Bernstein, 1994) and a measure is only valid when “the differences in observed scores reflect true differences on the characteristic one is attempting to measure, and nothing else (Churchill, 1995:65).

Validity is inferred from the manner in which a scale is constructed, its ability to predict specific events, or its relationship to measures of other constructs, i.e. content, criterion-related or construct validity.

The methods used to develop the scale items, presented in Chapters 3 and 5 can help to maximise item appropriateness and, therefore, improve content validity.

Another method of testing validity is through the replication of previous tests. As can be seen from Table 7.27, the fact that many of the alpha values for this study concur with the scales that were replicated from previous studies is encouraging.

However, some reliability values were not comparable with previous studies because the study scales did not produce unidimensional solutions when tested using factor analysis. Other scales were developed specifically for the study, using the findings of the exploratory research (Chapter 3).

The findings of these correlations suggest that the scales developed are valid and reliable and therefore, can be used in further analysis.
7.4 MODEL ESTIMATION

Four multiple regression analyses were undertaken to estimate the relationship between the independent factors and each of the four dependent performance measures identified during the model operationalisation (Section 7.3). For each performance factor the technique of least-squares was used to estimate the regression coefficients (b) in an equation:

\[ Y = \alpha + b_1X_1 + b_2X_2 + \ldots + b_{14}X_{14} + E \]

Where \( Y \) is the dependent variable, \( \alpha \) is the constant and \( E \) is the error associated with the prediction of \( Y \). Each predictor variable is weighted and these weights are known as regression coefficients.

A total of 76 cases were available for this stage of the analysis. Arguably, the sample size is small which meant that the likelihood of finding any significant relationships was reduced. However, “small sample sizes are no more likely to result in wrongfully claiming a relationship exists than for larger samples” (Speed, 1994:91), but, they do have a direct impact on the appropriateness and the statistical power of multiple regression (Hair et al., 1995). The power of a test is defined as “the probability of rejecting the null hypothesis when it should be rejected” (Diamantopoulos and Schlegelmilch, 1997) and affects the likelihood of a type II error (not rejecting the null hypothesis when it is, in fact, false. This is because the power of the test = 1 - type II error). Therefore, for a set sample size the only way to increase the power of the statistical test is to change the significance level (Cohen and Cohen, 1983), i.e. increase the likelihood of accepting that variable X does influence Y, when this is true.

With this in mind and due to the exploratory nature of the analysis the significance level was set at 0.10 This increase in the significance level makes it easier for variables to stay in the models for further examination, because, whilst performance was identified as being related to all the 14 predictor variables (see section 7.3.15), what is unknown is which predictor variables are related to each of the individual dimensions of performance.

A second issue related to sample size is its’ affect on the generalisability of the results through the number of predictor variables for the study model (Hair et al., 1995). As
the number of cases for each variable decreases, the error element in each observation has a larger impact on the analysis (Speed, 1994).

Hair et al. (1995) suggest a minimum ratio of five to one, but goes on to state that the preferable ratio is between 15-20. Kleinbaum et al. (1988) suggests a rule of thumb of \( n = 10k \), where \( n \) = sample size and \( k \) = number of predictors. For this study the ratio was 1: 5.4 which is above the suggested minimum of Hair et al. (1995).

Another problem that can occur with this type of data is multicollinearity, i.e. the correlation among two or more independent variables (evidenced when one is regressed against the others) (Hair et al., 1995). Because all the stages of the NPD process are part of an overall development process they are, therefore, very likely to be, at least, slightly correlated.

The impact of multicollinearity is to reduce any individual independent variable’s predictive power by the extent to which it is associated with the other independent variables (Hair et al., 1995) and can be a major problem for researchers wanting to use regression techniques because the interpretation of and conclusions drawn can be misleading (see Belsley, 1991; Krishamurthi and Rangaswamy, 1987; Mason and Perreault, 1991).

Multicollinearity means that it becomes a matter of luck as to how these correlated variables will be included in a function (Speed, 1994). This can inflate the variance of regression coefficients (Stewart, 1987) and introduce considerable instability into the coefficients. It increases the likelihood of failing to detect significant predictors (Type II error) and can also mean that individual variables which appear to lack significant explanatory power, can collectively be associated with significant explanatory power and should therefore, be considered.

However, robustness of the technique is what is important to researchers, i.e. it’s performance when the assumptions are violated and “the robustness of a technique in statistical terms may not affect its’ performance in practical terms” (Speed, 1994 : 95).

Most statistical packages now offer collinearity diagnostics which provide a means of assessing multicollinearity (Hair et al., 1995). Two of the more common measures utilised are Tolerance values (\( \text{Tol.} = 1 - R_i^2 \)) and its’ inverse, the Variance Inflation
Factor (VIF). \( VIF = \frac{1}{1 - R_i^2} \) where \( R_i^2 \) = multiple correlation from the regression of \( X_i \) on all of the other \( X \)'s (Fox, 1991; Hair et al., 1995; Norusis, 1997).

Tolerance, therefore, is the strength of the linear relationships among the independent variables, and is “the proportion of variability of that variable that is not explained by its linear relationships with the other independent variables in the model (Norusis, 1997:457, emphasis in the original). Hair et al. (1995) suggest that tolerance levels of below 0.1 are unacceptable, corresponding to a VIF value exceeding 10.0. Marquardt (1970) also states that a maximum VIF greater than 10 is thought to indicate harmful collinearity. However, as Hair et al. (1995) point out, these recommended thresholds still allow for substantial collinearity. It is, therefore, up to the researcher to determine the degree of collinearity that they are willing to accept. Green, Tull and Albaum (1988:457) suggest that “usually, one would want to guard against having any of these multiple correlations exceed the multiple correlation of the criterion variable with the predictor set”, i.e. the overall \( R^2 \) value. This is also suggested as a common rule of thumb by Mason and Perreault (1991), and means that multicollinearity is a problem if any of the \( R_i^2 \) values exceed the overall \( R^2 \).

Another commonly employed collinearity diagnostic is the Condition Index. This is “a standardised index of the global instability of the least-squares regression coefficients” (Fox, 1991:350) and they go on to state that a large condition index (say 10 or more) indicates that relatively small changes in the data will tend to produce large changes in the regression coefficients. Hair et al. (1995:152) suggests that condition index threshold is usually between 15 and 30, with 30 being the most commonly used. Hair et al., (1995:153) then state that, for all condition indexes exceeding this threshold value, the researcher must then identify all variables with variance proportions above 0.50, and a collinearity problem is indicated by a conditional index accounting for a substantial proportion of variance (suggested at 0.90 or above) for two or more coefficients. High variance proportions show where the observed correlations are affecting their coefficients (Norusis, 1993). Belsley (1991) suggests that “a condition index of 30 seems quite reasonable for many purposes” and “that estimates shall be deemed degraded when more than 50% of the
variance of two or more coefficients is associated with a single high scaled condition index” (Belsley, 1991:129).

Any combination of small sample size, low overall model fit, or extreme multicollinearity precludes confidence in understanding (Mason and Perreault, 1991). What is important to remember, however, is that “the impact of small sample size, high collinearity and low “true” relationship strength is to increase test conservatism” (Speed, 1994:96). Researchers are more likely to not find significant findings than significant findings that are wrong.

Initially, in estimating the regressions all independent variables were entered simultaneously in the equation (i.e. forced entry). Although sequential search procedures are often used to find the “best” regression model (Hair et al., 1995), the researcher first wished to test, a priori, all the predictors which had selected on the basis of theoretical considerations (Chapter 4). The study is trying to find evidence for the alternative hypothesis that, the c.s.f. differ depending on the dimension of success. Therefore, it would be expected that different variables could show different results (i.e. significant or not significant) for each of the four regression equations.

First, to check that the assumptions of regression analysis were satisfied, the researcher performed a “dry run” on all regression equations (Fox, 1991; Hair et al., 1992; Kleinbaum et al., 1988; Speed, 1994). In multiple regression, once the variate has been derived, it acts collectively in predicting the dependent variable, and the principal measure of prediction error for the variate is the residual (i.e. the difference between the observed and predicted values).

The assumptions are, that: 1) the observations are independent; 2) the relationship between the dependent and independent variables is linear; and 3) for each combination of values of the independent variables, the distribution of the dependent variable is normal with a constant variance (Norusis, 1997).

Assumption of normal distribution is the most frequently violated assumption (Hair et al., 1995). The simplest diagnostic check is to look at histograms of the residuals, however, any violations are particularly difficult to detect with smaller sample sizes because the distribution is not well formed (Hair et al., 1995). A better method is to check the normal probability plot (Hair et al., 1995). If residuals are normal, then the
residual line will closely follow the diagonal (Fox, 1991; Hair et al., 1995; Speed, 1994). Assumptions of linearity and constant error variance are checked by looking at standard residual scatter plots and violations of each assumption can be identified by specific patterns of residuals (Hair et al., 1995). The results of the dry-run did not provide a basis for rejecting these assumptions.

Outliers and influential observations were also detected using standardized residuals greater than three (i.e. 3 standard deviations above or below the mean) for all the four regression equations. In general, standardised residuals larger than three standard deviations are considered outliers (Norusis, 1993).

‘Leverage’ was also used to identify cases with unusual combinations of values of the independent variables. ‘Leverage’ measures how far the values for a case are from the means of all the independent variables and ranges from 0 to 1 (Norusis, 1997). Cases with high leverage values may have a large impact on the estimates of the regression coefficients \(^4\), and the analyst is encouraged to delete truly exceptional observations (Hair et al., 1995) to make the data set most representative of the actual population. This helps to ensure validity and generalisability of the findings (Hair et al., 1995).

These procedures identified outliers for all of the performance factors (see Table 7.28), which were consequently removed from further analysis.

Table 7.28 - Outliers Identified for each Dependent Variable

<table>
<thead>
<tr>
<th>Performance Dimension</th>
<th>Number of Outliers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial</td>
<td>2</td>
</tr>
<tr>
<td>Customer-based</td>
<td>3</td>
</tr>
<tr>
<td>Product-based</td>
<td>4</td>
</tr>
<tr>
<td>Window of Opportunity</td>
<td>1</td>
</tr>
</tbody>
</table>

As expected, the “dry run” also identified that multicollinearity was present (see section 7.5).

\(^4\) The rule of thumb is given as \(2p/N\), for \(p>10\) and \(n>50\), where \(p\) = number of independent variables and \(N\) = number of cases (Hair et al., 1995; Norusis, 1997).
7.5 OVERALL PERFORMANCE MODELS

The results for each of the dependent success dimension variables when all the variables are entered simultaneously are presented in Table 7.29.

7.5.1 FINANCIAL SUCCESS

The regression analysis results with financial success as the dependent variable are shown in Table 7.29 and the regression equation explains 28.7% of the variation in the dependent variable (F = 3.103, p = 0.001). Only one variable (performance advantage) shows significant effects at the 10% level (p = 0.092). This is the performance advantage variable which has a positive impact on financial success. The tolerance values identify an obvious problem with multicollinearity, especially for technical assessment and concept development and evaluation, which are both below the R² value (as suggested by Green et al., 1988; Mason and Perreault, 1991). Another anomaly that can occur because of multicollinearity is also identified from the equation model. Despite having the highest coefficient the concept development and evaluation variable is not significant (Nunnally, 1994).

7.5.2 CUSTOMER-BASED SUCCESS

The initial equation with all 14 predictor variables explains 42.9% of the variance in the dependent variable, customer-based success (F = 4.865, p = 0.000). However, only two of the 14 variables show significant effects and the tolerance values, again indicate that there is an obvious problem with multicollinearity.

The two significant variables are Concept Development and Evaluation, followed by Launch. No significant influences can be observed for any of the other predictor variables, although the t-value for Market Assessment is only just above the 0.10 threshold.

Unexpectedly, Concept Development and Evaluation have a negative effect on customer-based success, (and showed negative, but non-significant effects, for both product-based and window of opportunity success) however, this could be a result of the high multicollinearity which can affect the direction of the coefficient (Mason and Perreault, 1991; Stewart, 1987). Alternatively, these could be the correct coefficient directions which could suggest that the conceptual model may not have been correctly
specified, or provide evidence that previous, more general studies have failed to identify attributes unique to each of the success dimensions.

7.5.3 PRODUCT-BASED SUCCESS

The regression equation with all predictor variables entered explains 73.9% of the variation in the dependent variable, product-based success \((F = 11.512, p = 0.000)\). Eight of the 14 predictor variables show significant effects at the 10% level.

Five of the eight significant variables have positive coefficients as expected. These are uniqueness advantage, delivery advantage, technical assessment, design, and launch. However, performance advantage, process testing and market potential all have a negative influence on Product-based success. This could, again, be for any one of the reasons highlighted above.

7.5.4 WINDOW OF OPPORTUNITY SUCCESS

The initial equation with 14 predictor variables explains 52.9% of the variation in the dependent variable, window of opportunity success \((F = 4.807, p = 0.000)\). However, only three of the 14 variables show significant results. These were design, product testing, and market potential. The remaining eleven all show non significant influences. As expected, all three significant variables have a positive influence in Window of Opportunity success.

7.5.5 SUMMARY

These simultaneous entry results show that multicollinearity is a problem, especially for technical assessment, concept development, design and process testing which all have tolerance values below 0.4. However, despite these low tolerance values, none of these variables showed problems in the collinearity diagnostics. No condition index over 10 had more than one variable with a variance proportion over 0.50 for any of the four regression equations.

However, the problem of non significant results could equally be due to the small sample size as discussed earlier, or because the fit of the overall model is not strong for each of the individual dimensions of success.
Table 7.29 - Summary of the Four Overall Success Equations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Financial Success</th>
<th>Customer-based Success</th>
<th>Product-based Success</th>
<th>Window of Opportunity Success</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>Beta</td>
<td>Tol.</td>
<td>t-value</td>
</tr>
<tr>
<td>Uniqueness Advantage</td>
<td>.021</td>
<td>.023</td>
<td>.599</td>
<td>.182</td>
</tr>
<tr>
<td>Cost Advantage</td>
<td>.049</td>
<td>.055</td>
<td>.704</td>
<td>.468</td>
</tr>
<tr>
<td>Performance Advantage</td>
<td>.272</td>
<td>.235</td>
<td>.519</td>
<td>1.714</td>
</tr>
<tr>
<td>Delivery Advantage</td>
<td>-.107</td>
<td>-.122</td>
<td>.646</td>
<td>-.992</td>
</tr>
<tr>
<td>Market Assessment</td>
<td>.182</td>
<td>.176</td>
<td>.443</td>
<td>1.188</td>
</tr>
<tr>
<td>Technical Assessment</td>
<td>.263</td>
<td>.258</td>
<td>.206</td>
<td>1.187</td>
</tr>
<tr>
<td>Concept Development</td>
<td>.344</td>
<td>.337</td>
<td>.213</td>
<td>1.576</td>
</tr>
<tr>
<td>Design</td>
<td>-.196</td>
<td>-.246</td>
<td>.335</td>
<td>1.444</td>
</tr>
<tr>
<td>Co-ordination Process</td>
<td>-.024</td>
<td>-.023</td>
<td>.510</td>
<td>-.164</td>
</tr>
<tr>
<td>Product Testing</td>
<td>-.154</td>
<td>-.154</td>
<td>.445</td>
<td>1.040</td>
</tr>
<tr>
<td>Process Testing</td>
<td>-.061</td>
<td>-.063</td>
<td>.353</td>
<td>-.377</td>
</tr>
<tr>
<td>Launch</td>
<td>.110</td>
<td>.140</td>
<td>.456</td>
<td>.955</td>
</tr>
<tr>
<td>Market Potential</td>
<td>.133</td>
<td>.131</td>
<td>.631</td>
<td>1.056</td>
</tr>
<tr>
<td>Market Competition</td>
<td>-.111</td>
<td>-.098</td>
<td>.806</td>
<td>-.887</td>
</tr>
<tr>
<td>(Constant)</td>
<td>.501</td>
<td>n/a</td>
<td>n/a</td>
<td>.339</td>
</tr>
</tbody>
</table>

Note: The table provides a summary of the coefficients, standard errors, and p-values for various models of success equations, including financial, customer-based, product-based, and window of opportunity success.
7.6 COPING WITH COLLINEARITY

Normally, each regression equation is first estimated with all expected predictors, then parameters re-estimated after eliminating non-significant predictors. However, problems with multicollinearity can mean that variables do not show significant influences because of the multicollinearity even though they are important and can, therefore, be wrongly left out of the model.

The literature has suggested several strategies for dealing with collinear data (see Cohen and Cohen, 1983; Fox, 1991; Hair et al., 1995). However, as Fox (1991) notes, methods that are commonly employed as cures for collinearity, such as, model respecification, variable selection and biased estimates, can easily be worse than the problem.

Therefore, for this study two approaches for coping with collinearity were chosen. The first strategy chosen to deal with the inherent problems in the data was to run factor analysis on the 14 predictor variables to identify principal components. The objective was to reduce the large number of original variables into a smaller number of uncorrelated variables which can then be used in a subsequent regression analysis by computing factor scores (Fox, 1991; Hair et al., 1995; Mason and Perreault, 1991). Factor scores are "composite measures for each factor representing each subject" (Hair et al., 1995: 390).

This provides a solution that is statistically more robust because: it reduces the effect of noise/random variation (Fox, 1991); represents a composite of all variables loading on the factors, and therefore, there is no loss of information through the removal of any variables as with some other techniques for dealing with collinearity (Hair et al., 1995) and; removes the problem of multicollinearity. It also has the added advantage of reducing the number of predictor variables.

However, the factor scores are based on correlations with all the variables in the factor, which means that factor loadings are likely to be less than 1.0, because the variables can also load on other factors. This implies that they are only approximations of the underlying factors and as such, could well be error prone (Hair et al., 1995). The factors can also be difficult to interpret (see Churchill, 1995; Hair et
al., 1995). Factors may include variables that do not fit together conceptually and researchers can ignore variables in the naming process in order to make this task easier. Another issue with this method is the loss of detail, meaning that any findings will be, by definition, more general and possibly, therefore, of less use to practitioners.

The second strategy for dealing with the multicollinearity is via variable selection (Fox, 1991) which aims to reduce the predictor variables in the model to a less highly correlated subset. This approach was also chosen because it provides a means of reducing collinearity without having to arbitrarily remove variables and risk mis-specifying the model. All the variables have already been identified by previous studies as influencing performance and should, therefore, be considered. This is especially important as the goal of the research was to uncover the specific c.s.f. for each of the success dimensions.

When using variable selection the analyst must be aware of certain caveats. Firstly, multicollinearity can have a substantial impact on the final model specification when using sequential search approaches (Hair et al., 1995). Therefore, the researcher must assess the effects of multicollinearity in model interpretation and examine the direct correlations of all potential independent variables to avoid concluding that the individual variables that do not enter the model are inconsequential. A second problem with variable selection is that it “produces biased coefficient estimates if the deleted variables have non zero β’s and are correlated with the included variables (Fox, 1991:363). A third is that this method is frequently abused by researchers attempting to interpret the order of entry of variables into the regression equation as an index of their “importance” rather than using the beta weights (Fox, 1991:356).

When there is a problem with multicollinearity these variable selection regression procedures do not always result in the same equation, however, the researcher “should be encouraged when they do” (Norusis, 1993:351). Therefore, two methods were chosen, forward selection and backward elimination, in order to be able to compare the regression equations produced by each method. The similarity of findings for the forward and backward elimination regression models, especially if the beta values are similar, suggests that the equations are stable, and often, at least one will identify the
"best" subset (Fox, 1991; Hair et al., 1995). The most popular sequential approach to variable selection is stepwise estimation which is a combination of the other two approaches. However, this method would only differ from the forward selection method in the event of a variable already in the model becoming "unimportant" when another variable is added (Norusis, 1997:467).

Forward selection and backward elimination regression was used to determine which of the 14 independent variables to include in the final regression equation for each of the four performance dimensions. Both methods sequentially add or remove variables from a model based on how much the variable entered or removed changes the multiple $R^2$ given the variables that are already in the model. Forward selection regression is based upon adding variables one at a time, starting with only the constant term. Variables that result in the largest increase in $R^2$ are added at each step, provided that the change in $R^2$ is large enough for the researcher to reject the null hypothesis that the true change is 0. Backward elimination starts with a model including all the predictor variables and then removes variables one at a time. At each step the variable that alters $R^2$ the least is removed. The model stops removing variables when the removal of any variable in the model results in a significant change in $R^2$.

As discussed earlier, the significance level was set at 0.10, which makes it easier for variables to enter/stay in the model. A partial F value is calculated for each variable to determine whether they make a statistically significant contribution to the $R^2$ when the variable in question enters, or is removed from, the equation, i.e. how much evidence is required to reject the null hypothesis that the variable is not needed.

Appendices 7.1 and 7.2 show the residual plots for the final regression equations for each of the four performance dimensions, for each of the two strategies (i.e. factor analysis and variable selection respectively).

7.7 PRINCIPAL COMPONENT ANALYSIS RESULTS

The results of the rotated factor solution shown in Table 7.30 identify that four distinct principal components emerge from the 14 predictor variables, which collectively explain 68.6% of the variation.
Factor one includes all the development process variables (i.e. market and technical assessment, concept development, design, co-ordination processes, product and process testing, and launch) and explains 39.9% of the variation, and has been termed NPD process.

Factor two contains the variables, uniqueness advantage, performance advantage and market potential and explains 11.1% of the variation amongst the variables. This factor is all about the ‘customers’ need for innovation’, including items about unique features, highly innovative product, something that improves the customers operation, meeting customer needs, superior quality, as well as customers having a great need for the product, and a large/growing market.

Factor three contains variables associated with advantages through product cost and delivery (volume and availability).

These are two distinct marketing mix categories which are used to achieve product differentiation.

The fourth factor only includes the market competitiveness variable and is, therefore, named as such. This variable accounts for 7.8% of the variation.

<table>
<thead>
<tr>
<th>Table 7.30 - Factor Analysis of Predictor Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor</strong></td>
</tr>
<tr>
<td>Factor 1: NPD Process</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Factor 2 - Customers' Need for Innovation</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Factor 3 - Cost/Delivery Advantage</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Factor 4 - Market Competitiveness</td>
</tr>
</tbody>
</table>

207
The variable loading indicate how highly the variables correlate with the underlying factor and their square indicates the proportion of the variation in the variable that is accounted for by the factor (Hair et al., 1995).

As discussed in section 7.6, factor scores were computed for each of the factors identified. The original data measurements and the factor analysis results are used to compute factor scores for each case. The factor scores represent the degree to which each case scores high on the group of items that load high on a factor (Hair et al., 1995). These factor scores were calculated using the regression method (SPSS default method). Regression factor scores have a mean of 0 and variance equal to the squared multiple correlation between the estimated factor scores and the true factor value. This method minimises the sum of squared discrepancies between true and estimated factors over individuals (Norusis, 1997).

7.7.1 FINANCIAL SUCCESS

The regression equation with all predictor variables entered explains almost 32% of the variation in the dependent variable (Table 7.31), and three of the four predictor variables show significant effects at the 10% level (NPD process, cost/delivery advantage and market competition).

Table 7.31 - Summary Statistics of Factor Scores for Financial Success

<table>
<thead>
<tr>
<th>Summary Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple R</td>
</tr>
<tr>
<td>.562</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>NPD process</td>
</tr>
<tr>
<td>Customers’ need for innovation</td>
</tr>
<tr>
<td>Cost/delivery advantage</td>
</tr>
<tr>
<td>Market competitiveness</td>
</tr>
<tr>
<td>Constant</td>
</tr>
</tbody>
</table>

N/A - not applicable
Specifically, the beta values show that the NPD process was the most important variable, then cost/delivery advantage, followed by market competitiveness. All the influences were as expected, i.e. the NPD process and the level of product advantage were expected to positively influence new product success and market competitiveness is expected to negatively influence new product success. Customers’ need for innovation showed a non-significant, but positive effect.

### 7.7.2 CUSTOMER-BASED SUCCESS

The regression equation with all predictor variables entered is shown in Table 7.32 and explains almost 46% of the variation in the dependent variable, customer-based success. Three of the four predictors show significant effects and are all positive, as anticipated. The strongest influence is observed with factor one, then factor two, followed by factor three. Factor four shows a non-significant and negative effect.

Table 7.32 - Summary Statistics of Factor Scores for Customer-based Success

<table>
<thead>
<tr>
<th>Summary Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple R</td>
</tr>
<tr>
<td>.676</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>NPD process</td>
</tr>
<tr>
<td>Customers’ need for innovation</td>
</tr>
<tr>
<td>Cost/delivery advantage</td>
</tr>
<tr>
<td>Market competitiveness</td>
</tr>
<tr>
<td>Constant</td>
</tr>
</tbody>
</table>

N/A - not applicable

### 7.7.3 PRODUCT-BASED SUCCESS

All four predictors for the product-based success regression equation are significant and explain 48.6% of the variation (Table 7.33).
The most important variable is the NPD process, followed by cost/delivery advantage, then market competitiveness and finally, customers' need for innovation. All of the factors have positive influences on the dependent variable, product-based success. The NPD process, customers' need for innovation and cost/delivery advantage variables are expected to positively influence performance, however, as identified from previous studies, market competitiveness was expected to have a negative influence. This suggests that aiming to achieve product-based success is a successful strategy when the market is more competitive.

### Table 7.33 - Summary Statistics of Factor Scores for Product-based Success

<table>
<thead>
<tr>
<th>Summary Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple R</td>
</tr>
<tr>
<td>.697</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>NPD process</td>
</tr>
<tr>
<td>Customers' need for innovation</td>
</tr>
<tr>
<td>Cost/delivery advantage</td>
</tr>
<tr>
<td>Market competitiveness</td>
</tr>
<tr>
<td>Constant</td>
</tr>
</tbody>
</table>

N/A - not applicable

### 7.7.4 WINDOW OF OPPORTUNITY SUCCESS

As shown by table 7.34, the regression equation with all four predictor variables entered explains nearly 46% of the variation in the dependent variable, window of opportunity success. Only three of the four factors show significant effects, the NPD process, customers' need for innovation and market competitiveness and they all influence the dependent variable as predicted. Cost/delivery advantage does not show a significant effect, but the beta value is positive.

In terms of beta values, customers' need for innovation is the most important variable, next is the NPD process, followed by market competitiveness.
Table 7.34 - Summary Statistics for Window of Opportunity Success

<table>
<thead>
<tr>
<th>Summary Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multiple R</strong></td>
</tr>
<tr>
<td>.676</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>NPD process</td>
</tr>
<tr>
<td>Customers' need for innovation</td>
</tr>
<tr>
<td>Cost/delivery advantage</td>
</tr>
<tr>
<td>Market competitiveness</td>
</tr>
<tr>
<td>Constant</td>
</tr>
</tbody>
</table>

N/A - not applicable

7.7.5 SUMMARY

Table 7.35 provides a summary of the findings of the four regression equations for the factor analysis. Appendix 7.1 shows the residual plots for each of the four factor score regression equations.

Overall, the findings in table 7.35 show that, generally, all the internal variables are the more important drivers of performance (shown by the larger beta values). This is consistent with the findings of previous studies (Calantone et al., 1996; Montoya-Weiss and Calantone, 1994).

Specifically, the findings show that it is important that the whole process is undertaken well, which concurs with the findings of previous studies (Cooper, 1979a, 1979b, 1994; Cooper and Kleinschmidt, 1987a, 1993a, 1993b). All four of the equations show the NPD process to be significant at the 1% level (p < 0.000 for all four regression equations), and for Financial, Customer-based and Product-based success it is also the most important factor, shown by the beta weights.

‘Customers’ need for innovation’ (factor two) is significant for three of the four performance dimensions. Both customer-based success and window-of-opportunity success are significant at the 1% level (p < 0.000 for both). Product-based success
shows a significant effect at the 10% level (p= 0.097). Financial success shows no significant effect for factor two, customer's need for innovation.

Having a cost/delivery advantage is significant for three of the four performance dimensions, significant at the 1% level (p = 0.000) for product-based success and significant at the 5% level for financial and customer-based success (p= 0.046 and p = 0.020 respectively). However, the window of opportunity dimension shows no significant effect.

The higher significance level of product-based success could be linked to the competitiveness of the market (shown by the positive beta value) i.e. firms that have a cost/delivery advantage are more likely to be successful when many other suppliers are also competing for business.

Having a product advantage has been found to be one of the most important drivers of new product success by previous studies (Cooper, 1979a; Cooper and Kleinschmidt, 1987 b, 1987c; Maidique and Zirger, 1984; Song and Parry, 1996), this is confirmed by the findings of the factor score equations which show product advantage of one form or another (factors 2 and 3), to be significant for all the success dimensions.

Market competitiveness (factor four) produced two significant results at the 5% level for product-based (p = 0.040) and window of opportunity (p = 0.030) success and one at the 10% level for financial success (p = 0.081), however, unexpectedly, product-based success had a positive coefficient sign. Most previous studies stated that the competitiveness of the marketplace had a negative impact on success and suggest the avoidance of highly competitive markets (Cooper, 1975; Parry and Song, 1994; Zirger and Maidique, 1990). However, this is not always possible and the fact that market competitiveness is shown to have a positive impact on product-based success, suggests that this could be a successful strategy for firms faced with a highly competitive market.

The fact that market competitiveness showed significant effects for three of the performance dimensions could be seen to provide evidence contrary to the findings of past studies which have found the market environment to be less important (Cooper 1979a, 1979b; Cooper and Kleinschmidt, 1987b, 1987c; Montoya-Weiss and Calantone, 1994).
### Table 7.35 - Summary of Regression Equations for Four Factor Solution

<table>
<thead>
<tr>
<th></th>
<th>R2</th>
<th>NPD process</th>
<th>Customers’ need for innovation</th>
<th>Cost/delivery advantage</th>
<th>Market competitiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial Success</strong></td>
<td>0.32</td>
<td>(+) ✓</td>
<td>(+) ✓</td>
<td>(-) ✓</td>
<td>(-) ✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*** (.486)</td>
<td>** (.203)</td>
<td>* (.176)</td>
<td></td>
</tr>
<tr>
<td><strong>Customer-based Success</strong></td>
<td>0.46</td>
<td>(+) ✓</td>
<td>(+) ✓</td>
<td>(+) ✓</td>
<td>(-) ✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*** (.513)</td>
<td>*** (.337)</td>
<td>** (.213)</td>
<td></td>
</tr>
<tr>
<td><strong>Product-based Success</strong></td>
<td>0.49</td>
<td>(+) ✓</td>
<td>(+) ✓</td>
<td>(+) ✓</td>
<td>(+) ✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*** (.541)</td>
<td>* (.148)</td>
<td>*** (.359)</td>
<td>** (.183)</td>
</tr>
<tr>
<td><strong>Window of Opportunity Success</strong></td>
<td>0.43</td>
<td>(+) ✓</td>
<td>(+) ✓</td>
<td>(-) ✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>*** (.349)</td>
<td>*** (.538)</td>
<td>** (.195)</td>
<td></td>
</tr>
</tbody>
</table>

* = significant at 10% level, ** = significance at 5% level, *** = significance at 1% level.

Figures in brackets = beta values

The ✓ identify the significant variables and the signs in brackets show whether these effects were positive or negative.

However, as identified earlier, the limitations of this method are that the findings produced are far less detailed and can be more difficult to interpret because they are made up of numerous different variables.

The next section presents the findings of the variable selection strategy.
7.8 VARIABLE SELECTION FINDINGS

7.8.1 FINANCIAL SUCCESS

The forward selection and backward elimination regression equations for financial success were identical, including the same two variables and having the same $R^2$. The stability of the equation is further emphasised by the beta weights of both equations being identical.

Table 7.36 - Summary Statistics for Financial Success Regression Equation

<table>
<thead>
<tr>
<th>Summary Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple R</td>
</tr>
<tr>
<td>.563</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Performance Advantage</td>
</tr>
<tr>
<td>Technical Assessment</td>
</tr>
<tr>
<td>Constant</td>
</tr>
</tbody>
</table>

N/A - not applicable

Only two predictor variables were found to be significant (Table 7.36) and explain about 32% of the variation in the dependent variable. As expected they both have a positive influence on financial success.

The equation suggests that technical assessment is more important than performance advantage, as shown by the larger beta value.

However, it can not be concluded that these are the only two important predictor variables for financial success or that the beta weights are correct because of the problems with multicollinearity.

The reason that so few variables have entered the model could be explained by the multicollinearity. Referring back to the factor analysis matrix, this shows that technical assessment is correlated to all the other process variables which could be why no other variables are significant. It could also mean that the beta value for technical assessment is inflated (Stewart, 1987).

Performance advantage is correlated with uniqueness and market potential which could explain why only one of these variables has entered the model.
Therefore, it may not be that any of these other variables are not important, but rather that the multicollinearity is reducing the likelihood of other variables entering. However, the fact that the equation is stable for both forward and backward stepwise methods suggests that the variables were not entered by luck alone, but rather that they are both important predictors of financial success. However, the fact that cost and delivery advantage and market competition produced two separate orthogonal factors and are, therefore, known to be uncorrelated with the variables that have entered the model, the researcher can be more confident in concluding that they have not entered the model because they are not significant.

7.8.2 CUSTOMER-BASED SUCCESS

The stability of the two variable selection regression equations was reasonably good with three out of the four indicators the same. The forward selection equation produced a marginally better solution, in terms of $R^2$ and tolerance values for the variables included in the model and was, therefore, chosen (Table 7.37). The backward elimination method included the process testing predictor variable instead of launch. However, the order of importance of these three variables is the same and the beta values for performance advantage, delivery advantage and design are very similar, which is encouraging.

Table 7.37 - Summary Statistics for Customer-based Regression Equation

<table>
<thead>
<tr>
<th>Summary Statistics</th>
<th>Multiple R</th>
<th>$R^2$</th>
<th>Adjusted $R^2$</th>
<th>F-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.676</td>
<td>.457</td>
<td>.425</td>
<td>14.320</td>
<td>.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter analysis</th>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>Beta</th>
<th>Tol.</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Performance Advantage</td>
<td>.198</td>
<td>.101</td>
<td>.204</td>
<td>.737</td>
<td>1.964</td>
<td>.054</td>
</tr>
<tr>
<td></td>
<td>Delivery Advantage</td>
<td>.133</td>
<td>.073</td>
<td>.182</td>
<td>.795</td>
<td>1.815</td>
<td>.074</td>
</tr>
<tr>
<td></td>
<td>Design</td>
<td>.194</td>
<td>.077</td>
<td>.279</td>
<td>.654</td>
<td>2.527</td>
<td>.014</td>
</tr>
<tr>
<td></td>
<td>Launch</td>
<td>.158</td>
<td>.073</td>
<td>.235</td>
<td>.680</td>
<td>2.168</td>
<td>.034</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>2.154</td>
<td>.684</td>
<td>N/A</td>
<td>N/A</td>
<td>3.148</td>
<td>.002</td>
</tr>
</tbody>
</table>

N/A - not applicable
Specifically, the equation shows that design is the most important predictor variable, followed by launch, then performance advantage and finally, delivery advantage. As expected, all of the predictor variables have positive coefficients.

However, the beta values for design and launch could be spuriously high because of multicollinearity with variables not included in the model (Fox, 1991). Also, it is not possible to state unequivocally that uniqueness advantage, market potential and cost advantage are not important because of their high correlations with performance advantage and delivery advantage.

7.8.3 PRODUCT-BASED SUCCESS

The regression analysis with product-based success as the dependent variable are shown in Table 7.38. Both methods produce exactly the same regression equation, explaining almost 73% of the variation in the dependent variable.

The backward elimination regression equation shows nine of the 14 variables being entered into the equation. The variables not entered were: cost advantage; market assessment; co-ordination process; product testing; and market competitiveness.

As expected, five of the predictors have positive influences on product-based success.

However, contrary to the conceptualisation of the study presented in Chapter 4, performance advantage, concept development and evaluation, process testing and market potential all have negative influences.

As can be seen from the tolerance values for the variables in the model, multicollinearity is a problem, especially for technical assessment and concept development and evaluation and could, therefore, be affecting the signs and the size of the coefficients. The collinearity diagnostics suggest that concept development and evaluation and the constant are highly dependent, showing variance proportions of over 0.50 (Belsley, 1991).
Table 7.38 - Summary Statistics for Product-based Success Equation

<table>
<thead>
<tr>
<th>Summary Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple R</td>
</tr>
<tr>
<td>.854</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Uniqueness</td>
</tr>
<tr>
<td>Advantage</td>
</tr>
<tr>
<td>Performance</td>
</tr>
<tr>
<td>Advantage</td>
</tr>
<tr>
<td>Delivery</td>
</tr>
<tr>
<td>Assessment</td>
</tr>
<tr>
<td>Concept</td>
</tr>
<tr>
<td>Development</td>
</tr>
<tr>
<td>Process Testing</td>
</tr>
<tr>
<td>Launch</td>
</tr>
</tbody>
</table>

N/A - not applicable

Therefore, the regression was run again after removing concept development and evaluation (Table 7.39).

Again the forward selection and backward elimination regression equations included the same predictor variables and the beta values were almost identical, which is promising. It also improved the tolerances values although, the tolerance for technical assessment is still fairly low at 0.301. However, the coefficient signs are still negative for performance advantage, process testing and market potential. This suggests that these are likely to be the correct signs for the coefficients and are not due to the problems with multicollinearity, as can sometimes be the case. The other five variables in the model all have positive signs, as expected.
Table 7.39 - Summary Statistics for Respecified Product-based Success

<table>
<thead>
<tr>
<th>Summary Statistics</th>
<th>Multiple R</th>
<th>R²</th>
<th>Adjusted R²</th>
<th>F-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>.842</td>
<td>.709</td>
<td>.672</td>
<td>19.146</td>
<td>.000</td>
<td></td>
</tr>
</tbody>
</table>

Parameter analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>Beta</th>
<th>Tol.</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advantage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>-.278</td>
<td>.114</td>
<td>-.218</td>
<td>.578</td>
<td>-2.432</td>
<td>.018</td>
</tr>
<tr>
<td>Advantage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delivery</td>
<td>.198</td>
<td>.075</td>
<td>.203</td>
<td>.777</td>
<td>2.630</td>
<td>.011</td>
</tr>
<tr>
<td>Advantage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical</td>
<td>.697</td>
<td>.139</td>
<td>.623</td>
<td>.301</td>
<td>5.026</td>
<td>.000</td>
</tr>
<tr>
<td>Assessment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td>.201</td>
<td>.092</td>
<td>.226</td>
<td>.432</td>
<td>2.185</td>
<td>.033</td>
</tr>
<tr>
<td>Process Testing</td>
<td>-.398</td>
<td>.115</td>
<td>-.371</td>
<td>.406</td>
<td>-3.477</td>
<td>.001</td>
</tr>
<tr>
<td>Launch</td>
<td>.412</td>
<td>.083</td>
<td>.476</td>
<td>.508</td>
<td>4.983</td>
<td>.000</td>
</tr>
<tr>
<td>Market Potential</td>
<td>-.190</td>
<td>.093</td>
<td>-.170</td>
<td>.663</td>
<td>-2.037</td>
<td>.046</td>
</tr>
<tr>
<td>Constant</td>
<td>.432</td>
<td>.845</td>
<td>N/A</td>
<td>N/A</td>
<td>.512</td>
<td>.611</td>
</tr>
</tbody>
</table>

N/A - not applicable

The equation, therefore, indicates that having a product of superior quality and meeting customer needs better reduces the likelihood of product-based success. This could mean that these are not attributes valued by the customer when purchasing these types of products. The model advocates that it is more important to concentrate on achieving uniqueness advantage and delivery advantage.

In terms of process testing, the equation proposes that undertaking off-tool production well, running capability studies to optimise the production process and carrying out employee training well reduces the likelihood of success. This could be due to the increased development costs involved when it is not necessary to do the activities as well as the rest.

In terms of market potential, the equation suggests that these types of products fair better customers do not a great need for the product of there is not a large/growing
market. This type of success strategy could be more successful for markets that are more stable or mature.

7.8.4 ‘WINDOW OF OPPORTUNITY’ SUCCESS

The regression equations were again different for the two methods (forward selection and backward elimination). The backward elimination model explains more of the variation in the dependent variable, 47.8%, as opposed to 43.3%. The forward selection model has four variables in and the backward elimination has six, but, only two of the same variables. However, unique product is the most important variable in both equations, followed by market potential. The remaining variables are different, with forward selection also including performance advantage and co-ordination process variables.

When referring back to the original equation with all variables entered, the three that show significant p-values are design, product testing, and market potential, which are all included in the chosen backward elimination equation (see table 7.40). This equation does not show signs that multicollinearity is a problem, with tolerance values all above 0.69 and corresponding VIF values all below 1.5 which are well within the acceptable ranges of Belsley (1991), Fox (1991) and Hair et al. (1995).

Table 7.40 - Summary Statistics for Window of Opportunity Success Equation

<table>
<thead>
<tr>
<th>Summary Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple R</td>
</tr>
<tr>
<td>.691</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Unique Product</td>
</tr>
<tr>
<td>Cost Advantage</td>
</tr>
<tr>
<td>Design</td>
</tr>
<tr>
<td>Product Testing</td>
</tr>
<tr>
<td>Market Potential</td>
</tr>
<tr>
<td>Market Competitiveness</td>
</tr>
<tr>
<td>Constant</td>
</tr>
</tbody>
</table>

N/A - not applicable
The most important predictor is having a unique product, then market potential, design, market competitiveness, next is product testing and finally, cost advantage. As anticipated all the predictor variables have positive impacts except for market competitiveness which has a negative impact on the dependent variable. However, because of the instability of the two equations (forward and backward) it is harder to be certain about the importance of the predictor variables or the interpretation of the variables not included in the model.

7.8.5 SUMMARY

Various combinations of the 14 predictor variables account for 30 percent to 69 percent of the variation in the four independent measures analysed. Table 7.41 provides a summary of the findings of the four regression equations, with ticks indicating significant predictors. Appendix 7.2 shows the residual plots for the final regression equations comprising each of the four variable selection models.

Technical assessment is significant at the 1% level for both financial and product-based success (p < 0.000 for both). Design and launch are the next most identified variables, showing significant for both customer and product-based success. Design is also identified as significant for Window of Opportunity success.

Uniqueness advantage is significant at the 1% level for both product-based success and window of opportunity success (p = 0.002 for both), but shows no significant effects for either financial or customer-based success.

Having a cost advantage is only significant for one performance dimension, window of opportunity success shows significant at the 10% level (p = 0.052).

Performance advantage is significant for three of the four dimensions. Two at the 5% level, which were financial and product-based success (p = 0.013, p = 0.018 respectively) and was significant at the 10% level for customer-based success (p = 0.054).

Market competition was only found to be significant for window of opportunity success.
The results also show that the market assessment, concept development and evaluation, and co-ordination process variables are not important drivers of success for any of the success dimensions.

One explanation for the lack of significant findings for market assessment could be to do with the structure of the industry. A large proportion of component suppliers actually work with customers throughout the development projects, shown by the large number of joint ventures with customers (55.3%, see section 6.5.3, Chapter 6). Therefore, suppliers would be provided with a large proportion of the market information by the VM’s who are often in a better position to determine what the ‘end user’ wants. This is, therefore, likely to be a finding specific to this industry.

The reason for concept development and evaluation not being important is most likely to do with the fact that this variable had the highest levels of multicollinearity. This means that it does not provide much unique information.

In terms of the co-ordination process variable it is very surprising that this variable does not show significant results for any of the equations given that more recent studies have been emphasising the importance of undertaking process activities in parallel with development.

The lack of significant results for these three variables could equally be because of the small sample.

What these findings do show is that the c.s.f. identified do differ depending on the dimension of success, providing support for hypothesis 1b.
### Table 7.41 - Summary of Regression Equations for Four Success Equations

<table>
<thead>
<tr>
<th></th>
<th>Financial Success</th>
<th>Customer-based Success</th>
<th>Product-based Success</th>
<th>Window of Opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2</td>
<td>0.30</td>
<td>0.43</td>
<td>0.69</td>
<td>0.43</td>
</tr>
<tr>
<td>Market Assessment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical Assessment</td>
<td>(+) ✓</td>
<td>(+) ✓</td>
<td>(+) ✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td>*** (.401)</td>
<td>*** (.729)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concept Development</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td>(+) ✓</td>
<td>(+) ✓</td>
<td>(+) ✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td>** (.279)</td>
<td>*** (.313)</td>
<td>** (.241)</td>
<td></td>
</tr>
<tr>
<td>Co-ordination Process</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product Testing</td>
<td></td>
<td></td>
<td></td>
<td>(+) ✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* (.178)</td>
</tr>
<tr>
<td>Process Testing</td>
<td></td>
<td></td>
<td></td>
<td>(-) ✓</td>
</tr>
<tr>
<td></td>
<td>*** (.338)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Launch</td>
<td>(+) ✓</td>
<td>(+) ✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>** (.235)</td>
<td>*** (.486)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unique Product</td>
<td></td>
<td></td>
<td></td>
<td>(+) ✓</td>
</tr>
<tr>
<td></td>
<td>*** (.268)</td>
<td>*** (.286)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance Advantage</td>
<td>(+) ✓</td>
<td>(+) ✓</td>
<td>(-) ✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td>** (.271)</td>
<td>(.204)</td>
<td>(-.196)</td>
<td></td>
</tr>
<tr>
<td>Market Potential</td>
<td></td>
<td></td>
<td></td>
<td>(+) ✓</td>
</tr>
<tr>
<td></td>
<td>** (-.194)</td>
<td>** (.250)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost Advantage</td>
<td></td>
<td></td>
<td></td>
<td>(+) ✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* (.177)</td>
</tr>
<tr>
<td>Delivery Advantage</td>
<td></td>
<td></td>
<td></td>
<td>(+) ✓</td>
</tr>
<tr>
<td></td>
<td>(+) ✓</td>
<td>(+) ✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>* (.182)</td>
<td>*** (.203)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market Competitiveness</td>
<td></td>
<td></td>
<td></td>
<td>(-) ✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>** (-.224)</td>
</tr>
</tbody>
</table>

* = significant at 10% level, ** = significance at 5% level, *** = significance at 1% level.
Figures in brackets = beta values
7.9 DISCUSSION OF ANALYSIS FINDINGS

This section presents a discussion of the findings of both the factor score equations and the variable selection equations.

First, the general findings will be discussed, then specific issues relating to the two methods will be presented, followed by what these mean for model usage. The double lines in Table 7.41 show the division of the variables by factors in order to aid interpretation of the two models.

7.9.1 GENERAL FINDINGS

Overall, consistent with previous findings (Cooper 1979a, 1979b; Cooper and Kleinschmidt, 1987a, 1993a, 1993b) the factor model shows that it is important to undertake all NPD activities well. The summary table (7.35) also shows that the internal project variables are more important than market competitiveness.

The factors identified differ slightly depending on the dimension of success but what is also interesting is that the importance of the factors differ depending on the success dimension. This provides evidence to support hypothesis 1b that the c.s.f. differ depending on the dimension of success.

In terms of the variable selection equation the overall problem is that whilst every effort was made to reduce the problems of collinearity (see section 7.6) it can still affect the beta weights in the equations produced. This can make it difficult to be certain about the relative importance of the variables. However, the fact that the variable selection equations have shown significant results despite the collinearity is encouraging, especially given the relatively small sample, both of which actually reduce the likelihood of finding significant results (Speed, 1994). Therefore, while the researcher can not categorically state that the variables not entering the model are not important, is possible to be more certain that the variables that have entered the model are correct (Speed, 1994).
7.9.2 SPECIFIC FINDINGS

Financial Success

The factor solution provides a better explanation of the variation, 32% over 30% for the variable selection equation, with three of the four factors identified as being significant. Customers' need for innovation (factor two) shows no significant effect suggesting that uniqueness, performance advantage, and market potential do not affect financial success. However, performance advantage was one of the only two variables to be identified as significant in the variable selection equation. The other was technical assessment. The lack of significant variables could be a consequence of the multicollinearity between the other variables that are known to be correlated with performance advantage and technical assessment, or a consequence of the small sample size. However, in practical terms this suggests that undertaking these two activities well explains 30% of financial success.

Customer-based Success

Both equations explain very similar amounts of variance, 46% for the factor score equation versus 43% for variable selection equation.

Three out of four factors are significant at 5% or less in the factor solution equation. The NPD process, customers' need for innovation and cost/delivery advantage. The specific model shows that, whilst firms should strive to undertake all activities well, design and launch activities are the most important (shown by their significance in the variable selection equation). Out of the two differential advantage factors, only performance and delivery advantage are identified by the variable selection model, suggesting that these are more important than the other variables which make up factors two and three.

Product-based Success

The findings of the two equations for the product-based success dimension differ significantly from the findings of previous studies.

The factor equation produced a much lower $R^2$ than the variable selection equation (0.49 as opposed to 0.69). This could be explained by the fact that the variable selection equation identified negative effects for some variables. This could have been
affecting the overall factor scores to the extent that the model did not explain the relationships very well.

In terms of the factor score equation, one very interesting finding is that market competitiveness does not have a negative effect on this dimension of success. Maybe, therefore, firms that are striving for success in a more competitive market should use product-based success strategies more, instead of avoiding competitive markets as suggested by previous research (e.g. Cooper, 1979a, 1979b).

**NPD Process**

Whilst the whole process is seen to be significant for all the four factor models, it is also the most important factor for all but the window of opportunity success, where customer need for innovation (factor two) is most important (shown by the larger beta value), followed by the NPD process.

However, the variable selection equations show a different picture. Only one activity is shown to be significant for financial success and only two for customer-based success and window of opportunity success. The product-based success equation identifies four activity variables as significant, however, the coefficient signs do not follow the expected patterns identified in Chapter 4.

**Product Advantage Variables**

In terms of the product advantage variables, while factor two, customers’ need for innovation, showed up significant for three of the four performance dimensions, especially for customer-based and window of opportunity success (significant at 0.01), the individual variables in the variable selection equations show very different patterns. In product-based success, the variable ‘uniqueness advantage’ showed positive signs, whereas performance and market potential show negative signs. The factor score which includes all these variables was shown to be significant at the 10% level ($p = 0.148$). However, obvious from the variable selection equation that these variables are producing different individual effects which are masked by the overall factor score for the first equation.
In terms of customer-based success, performance advantage is significant at 0.10 but neither uniqueness advantage nor market potential show significant effects. However, in the factor model customers' need for innovation was highly significant (p<0.01).

For window of opportunity success equation uniqueness advantage is highly significant (at 0.01) and market potential is significant at (0.05) but performance advantage is not significant at all. However, product-based success shows exactly the same pattern of individual variables but is much less significant in the overall factor model (0.10), instead of (0.01). Therefore, the combination of the variables can not be the reason. Other variables must provide a better explanation for the variation in the variable selection equations, who’s effects are masked in the factor model.

Factor three is different, in that it is made up of what are, essentially, two separate mix variables which can be used to achieve differential advantage (Jobber, 1998).

This factor shows significant for all but the window of opportunity success for the factor equations. At a more specific level though the patterns are very different. Neither cost or delivery advantage are important for financial success. Delivery is only significant at the 10% level for customer-based success. However, it is significant at the 1% level for product-based success, which could explain the high level of significance in the factor model.

Cost is only identified as a significant variable for the window of opportunity success equation and then only at the 10% level.

**Market Environment**

Contrary to the findings of many previous studies (Cooper, 1979a, 1979b; Cooper and Kleinschmidt, 1987c; Montoya-Weiss and Calantone, 1994), the findings of the factor equations show that the market environment is significant, although, in general it is less important that the other factors (except for product-based success where it is third). However, in the more specific equations the market environment does seem to be less important than the internal process variables. While market competitiveness showed significant in the factor score regression equations for both product and window success, it was only significant for the window of opportunity success in the more detailed variable selection regression equations (along with market potential).
In fact it was the first variable removed from the product-based success model i.e. it explained the least amount of variance in the product-based success variable.

Because market competition is only slightly correlated with any of the other variables (shown by its high variable loading on factor 4, 0.938) the researcher can be reasonably sure that it is not significant for three of the four success dimension in the variable selection model. However, this may be due to the small sample size.

7.9.3 MODEL USAGE

The factor models mostly concur with previous findings which suggest that undertaking the whole process well is important as well as having differential advantage. They also show that the market environment is less important in terms of competitiveness than the internal process variables.

However, the variable selection models shows that if only one variable within the factor is important, the effect of this one variable is enough to produce a significant result for the whole factor. Therefore, if the factor score equations were used, the researcher would make the assumption that all three variables that make up that factor are important for success, when in fact only one may be. What is also clear is that the factor solution actually disguises variables that have negative effects on the project performance, as shown by the variable selection equation for product-based success.

If practitioners were using the factor score equation they would make an assumption that the whole NPD process is most important, followed by a cost/delivery advantage, then by the market competitiveness and finally by the customers’ need for innovation. However, the variable selection model shows that only four of the NPD process activities are important (all significant at p < 0.01) and that process testing actually has a negative impact on success. All three of the variables that make up customers’ need for innovation are shown to be significant at the 5% level, however, two have negative effects which were hidden by the overall model.

The more detailed variable selection equation models provide much more information on specific activities that are related to each of the individual success dimensions and are, therefore, are more use to practitioners because they provide more specific details
about the importance of individual activities and identify variables that have potential negative effects on the project performance.

The fact that some of the findings of the individual models produce conflicting findings to those of the factor score models provides evidence to support the hypothesis that the use of simplistic models of the NPD process has made it difficult for practitioners to relate the findings to specific cases. Added to this is the fact that these overall models actually mask the actual differences in the c.s.f. for each of the dimensions of success, especially negative effects.

These findings also provide evidence to support the hypothesis that c.s.f. differ depending on the success dimension. These issues are explored in more detail in the next chapter which concludes the current investigation.
CHAPTER 8

CONCLUSIONS

The purpose of the study undertaken was to provide empirical evidence for the specific NPD process practices of automotive component suppliers, to confirm whether previously identified dimensions of success are applicable in the automotive components industry, and ascertain whether the c.s.f. differ depending on the dimensions of success. The findings to all these issues will provide more specific details for improving NPD performance.

The main aim of this final chapter is to consolidate the key findings of the research and highlight their implications for researchers and practitioners. These are initially discussed in a chronological order as the study progressed, then as a summary of what they actually mean for the specific hypotheses. Following this, the managerial implications of these findings are presented. In addition, the limitations of this study are discussed and recommendations for future research are made.

Using inputs from previous NPD research studies, together with the insights gained from the exploratory survey, data was collected on a successful new product and a failed new product developed by UK automotive component suppliers. These were significant development projects developed within the last five years.

The data was subsequently used to a) provide a descriptive account of NPD practices and performance in the UK automotive components industry, b) identify the success dimensions from the performance indicators measured, c) test a model of the factors affecting new product performance for each of the identified success dimensions, and d) determine whether they differ depending on the dimension of success.
8.1 STUDY IMPLICATIONS

8.1.1 EXPLORATORY INVESTIGATION FINDINGS

The exploratory investigation undertaken identified that there were several similarities and differences between practices in the automotive components industry and those investigated by previous studies. Many previously identified and used measures were corroborated, others were not found to be important, and many new measures were also identified, especially for the specific internal NPD process activities, which were a focus of the study.

In terms of the success measures identified, these were reasonably consistent with those identified by previous studies, which is encouraging, however, some differences were also observed for the automotive components industry. Other important performance criteria were observed. Some of these had been used before in other previous studies, such as window of opportunity on new markets and new products, whereas others were completely new measures. Quality was seen as two separate measures, reject levels and warranty levels. How well the project stayed within budget costs was also noted as a measure of performance by the managers interviewed. Two other measures recommended by Griffin and Page (1993, 1996) were not identified at all by the respondents: break-even time and revenue growth goals. These findings show the importance of conducting preliminary qualitative research to confirm the appropriateness of the measures used to capture performance results.

An important point arising from the qualitative interviews is that industry specific differences affect the appropriateness of many variables, including the success measures used. This leads the research to the conclusion that NPD success is dependent upon the situation and that researchers must confirm the appropriateness of the measure that they use and adopt a contingent approach to the study of NPD.

8.1.2 MODERATING INFLUENCES

This research also tested various potential moderators of the relationship between internal development process activities by analysing the general and NPD characteristics of the firm to determine whether they were associated with success or
failure. Only one of the variables studied was found to be significantly related to performance.

A major implication is that firm size does not affect performance. There seems to be no one best strategy for segmenting the market in order to achieve success. Developing projects as joint ventures is not sufficient to ensure successful new product performance. The length of time taken to develop the project did not discriminate well between success and failure.

However, one variable was found to be significantly related to performance. Internal sources of the new product idea are more likely to lead to a successful project outcome. This differs from previous study findings which identify that the source of the idea does not differentiate all that well between success and failure.

Contrary to the recommendations of previous studies, customer derived new product ideas were not found to lead to more successful new products. The implication of this is that firms should focus on developing their own methods of generating new product ideas by creating a more innovative culture.

8.1.3 NPD PROCESS SCALE RELIABILITIES

In terms of the scale constructs replicated from previous studies, some of the scales produced reasonably consistent reliability values, thus, confirming the temporal stability of these scales. The consistent reliability of this replication of the scales in a different context also enhances the external validity of these scales.

However, some of the scales were not comparable with previous studies because the measures used did not produce unidimensional solutions, or were not appropriate for the industry under investigation and were therefore, not used. These require further investigation to confirm their external validity and temporal stability.

An important finding arising from the scale development was that the product advantage scale were not unidimensional. This scale has been used before and alpha values calculated. However, when a scale is not unidimensional it is not possible to know exactly what the construct is measuring. Added to this is the fact that this
overall measure is more difficult for practitioners to interpret, because they can not be
sure what type of differential advantage is most appropriate for any given situation.
Thus, any future studies must bear in mind that, despite the lower reliabilities of these
scales (section 7.3.1, Chapter 7), these individual differential advantage measures
provide far more detailed information on which type of competitive advantage a firm
should be aiming to achieve.

8.1.4 SUCCESS DIMENSIONS

The current study identified four dimensions of success, thus confirming hypothesis
1a. These followed the same categories as previous studies, i.e. financial, customer-
based, product-based and window of opportunity success.

However, the items used to develop three of these constructs were not the same as
previous studies. Principal component analysis identified that the expected success
dimension items did not produce unidimensional solutions. The items that grouped
together were different than those used by the previous studies to calculate the
dimension constructs. A factor solution for all 18 success measures identified a
different factor pattern for this study when compared to previous work (Griffin and

Financial success was measured using the following items: exceeded company’s profit
levels; exceeded margin goals; exceeded break-even time; exceeded IRR/ROI goals;
exceeded revenue goals; exceeded market share goals; exceeded sales volume goals
(units not revenue). The original financial success dimension identified and used did
not include the last three listed items. These were included in the customer-based
success dimension previously.

The customer-based success items were pertaining to, whether the product: exceeded
targets of customer acceptance; exceeded targets of customer satisfaction; met
acceptable reject levels; met acceptable warranty levels; exceeded the performance
specifications. As already identified the previous measures, identified by Griffin and
Page (1993, 1996) and used by Hultink et al. (1997), also included the three
mentioned above, and did not include product performance or the two quality items
that were used for this study (see section 3.3.3, Chapter 3). Previously these had been included in the project-based measure, however, conceptually, they do fit well with the customer-based measure because they are about whether the product reaches acceptable performance levels for the customer and whether the quality levels are acceptable to the customer.

Product-based success was made up of three items: being within budget constraints; being ready ahead of time, i.e. speed to market; and whether the product was launched on time. As already stated, the previously used measure also contained product performance and quality items.

The window of opportunity measure included the two expected measures of opportunity on a new product category and new market opportunity.

Therefore, it appears that the nature of success definition and measurement is not consistent. This is possibly due to the industry under investigation, although the researcher cannot be sure that these findings are industry specific without further study (see section 9.2). However, it can be concluded that they are different from previously published results.

The implication of this is that prior to any analysis of the determinants of new product performance attention should be focused on confirming that items used to measure any of the success dimension constructs are appropriate, consistent with theory, and unidimensional.

8.1.5 MODELLING OF THE CONSTRUCTS

Due to the high levels of multicollinearity identified, two estimation methods were utilised in order to identify the c.s.f. for each of the success dimensions. The first strategy used principal component analysis to identify a smaller number of uncorrelated variables, which were then regressed against each of the success dimensions (see section 7.7, Chapter 7). The second approach employed variable selection procedures to identify the significant variables (see section 7.8).
With regard to the regression analysis results (section 7.7 and 7.8, Chapter 7), the problems with multicollinearity and the small sample size means that any conclusions drawn from this section of the analysis must be treated with some care. These factors reduce the likelihood of finding significant results and mean that it can not be concluded that the variables that are not included in the model are not important (see section 7.6, Chapter 7). Also, the use of two alternative methods for calculating the regression equations means that interpretation of the findings can be difficult. However, despite these issues many important implications can be deduced. These are presented below. First, the implications for the principal component analysis are presented, then, those pertinent to the variable selection equations. Finally, the implications of both strategies are brought together.

**Model 1 - Factor Scores**

All four of the equations show the NPD process to be significant, thus, confirming that firms should undertake all the NPD process activities well. It is also the most important factor (see section 7.7.5, Chapter 7) affecting financial, customer and product-based success. It is the second most important factor for window of opportunity success. The importance of NPD process activities, highlighted by the findings (see Chapter 7), is consistent with the findings of previous studies.

Another major implication of the factor score equations is that differential advantage, of one form or another, is significant and positively related to all the success dimensions. This, of course, should not be interpreted as implying that it does not matter which sort of differential advantage a firm aims to achieve, because there are differences in both the significance levels and the importance (see section 7.7.5, Chapter 7) of the two factors that include all the measures of differential advantage.

- Cost/delivery advantage is the only significant advantage factor for financial success
- both cost/delivery advantage and customers' need for innovation are significant for customer and product-based success, however, customers' need for innovation
is more important than cost/delivery advantage for customer-based success and the opposite is true for product-based success

- only customers' need for innovation is significant for window of opportunity success.

Finally, the fact that market competitiveness showed significant effects for financial, product-based and window of opportunity success is contradictory to the findings of previous studies, which found the market environment not to be significant. In addition to being an important determinant of success the findings also show another interesting difference from previous studies. Market competitiveness is actually positively related to product-based success. Where previous research has found a relationship, it has always been found to be negative. This positive result suggests that product-based success can be a more successful strategy for developing a new product if the market is highly competitive.

Model 2 - Variable Selection

While the variable selection equations show fewer significant results, the implications that can be drawn from these equations are far more specific.

Distinctive NPD process activities that improve the likelihood of success can be identified for each of the four equations.

Different individual differential advantage measures are shown to be significant depending upon the dimension of success, which provides additional support for the conclusion that these individual measures should be used in future research in order to provide more detailed information to practitioners.

Market competitiveness was only found to be significant for window of opportunity success, thus, confirming previous study findings which identified the market environment to be less important in determining success or failure.

The results also show that market assessment, concept development and the coordination process variables were not significant for any of the variable selection equations. This could be because of the small sample size or because of the industry
under investigation. Therefore, further research into this specific area is required (see section 9.4).

**Comparing the Models**

When considering both models, however, the results become less clear. The detailed results show that the more general models are actually masking significant differences (especially potential negative effects) and providing 'average' c.s.f. which do not relate to any specific project situation. The implication of this is that the more general models, proposed by past research, are too simplistic to be applicable to any particular situation. This could provide an explanation as to why failure rates are still so high. Even if practitioners are using the findings presented in previous research, these findings are not specific to the situation in which they are being used. Therefore, decisions that practitioners are making based on these more simplistic models could actually reduce the likelihood of developing a successful new product.

The variable selection models provide more detailed information that practitioners will actually be able to utilise. The practical implications of these findings will be discussed in more detail in section 9.3.

**8.2 HYPOTHESES CONCLUSIONS**

In terms of the specific relationships between the constructs and each of the success dimensions, most of the relationships found between the constructs and performance follow the expected directional patterns, thus, more strongly establishing their role in the NPD process.

In terms of the specific hypotheses put forward in chapter 4, each hypothesis is examined below and evidence for support or otherwise is presented.

**8.2.1 HYPOTHESES 1a AND 1b - SUCCESS DIMENSIONS**

The four dimensions of success identified from the factor analysis of the 18 performance measures, (see section 7.3.14) were financial, customer-based, product-
based and window of opportunity success. Therefore, hypothesis 1a, that there are four dimensions of success in the automotive components industry, is accepted.

Hypothesis 1b, that the importance attached to the critical success factors (c.s.f.) differs depending on the dimension of success, can only be inferred from the findings of the remaining hypothesis. Therefore, the evidence presented for these hypotheses will be interpreted first, followed by what these findings mean in terms of supporting, or rejecting hypothesis 1b.

8.2.2 HYPOTHESES 2a-2d - NPD PROCESS ACTIVITIES

The model identified four stages to the NPD process relating to the four hypotheses to be tested (see section 4.2.2, Chapter 4). These activities are all included in the NPD process factor which was found to be significant for all four of the success dimensions. Therefore, providing proof for all the four NPD process hypotheses. However, the variable selection model provides further evidence which must also be considered before concluding that these hypotheses are fully supported.

Hypothesis 2a states that pre-development activities: including marketing and technical assessment and concept development and evaluation, are positively related to success. For the variable selection equations, only one of the three pre-development constructs was found to be significant, technical assessment, and only for financial and product-based success.

The lack of evidence to support hypothesis 2a, that pre-development activities are positively related to success, leads the researcher to reject this hypothesis.

Hypothesis 2b states that the quality of execution of design/development activities is positively related to new product success. The design construct is shown to be significant for three out of the four variable selection equations, customer-based, product-based and window of opportunity success. However, it is not found to be significant for financial success. The fact that undertaking design activities well is identified as important for three of the four success dimensions provides reasonable support for hypothesis 2b.
For the two testing and validation measures, only one positive effect is seen for either of the two constructs. Undertaking product testing and validation well is positively related to window of opportunity success. However, equally important is the negative effect that process testing and validation has on product-based success equation. These two variables are not important for either financial or customer-based success. Therefore, hypothesis 2c, that the quality of execution of testing and validation activities is positively related to new product success, is rejected.

Hypothesis 2d states that the quality of the market launch activities undertaken is positively related to success. In terms of the four success dimensions, the market launch variable is shown to be significant for only two of the equations at the 5% level, therefore, providing partial support for hypothesis 2d.

The differences in the variables identified as important depending on the dimension of success certainly provides substantial evidence to support hypothesis 1b, that the c.s.f. differ depending on the dimension of success.

8.2.3 HYPOTHESIS 3a AND 3b

The findings of the factor score models show that the hypothesis that product advantage is positively related to performance is supported for all four equations. Given the supporting evidence, hypothesis 3a, that product advantage is positively related to new product success, is not rejected.

The measure of non-product advantage (delivery advantage) is significant for three of the four factor score regression equations, thus, providing substantial support for hypothesis 3b, that non-product advantage is positively related to new product success.

These equations also show that the different types of differential advantage differ in both significance and importance for each of the four equations, thus providing more supporting evidence for hypothesis 1b, that the c.s.f. differ depending on the dimension of success.
The variable selection models again show that product advantage of one sort or another is positively related to new product success. However, they also show that different types of differential advantage are important for each of the success dimensions.

The implication of this is that the overall measure of product advantage has not provided the detailed information that practitioners have required in order to focus on producing a product with the appropriate type of differential advantage. Simply knowing that product advantage is important could have meant that they may still have been developing a product with the wrong type of advantage. The consequences of this will have been to reduce the chances of success. This is especially true for those products aimed at product-based success given that performance advantage actually has a negative effect on success.

Hypothesis 3b, states that non-product advantage is positively related to new product success, i.e. delivery advantage. Three of the four factor score equations show that the cost/delivery advantage factor is significant, financial, customer-based and product-based success. Two of the four variable selection equations also show delivery advantage to be significant. These findings provide partial support for this hypothesis, which is, therefore, not rejected.

Overall, what the findings of these two hypotheses show is that different measures of differential advantage are found to be important depending on the dimension of success. This, therefore, provides further support for hypothesis 1b.

8.2.4 HYPOTHESES 4a AND 4b

Regarding hypotheses 4a, that market potential is positively related to performance, the factor solution is unclear. This is because market potential is included with two internal product advantage measures in the customers need for innovation. However, this overall factor is significant for three out of the four equations, which provides limited support for this hypothesis.
In terms of the variable selection equations, only the window of opportunity success variable selection equation identifies a positive relationship between market potential and performance. Product-based success actually identifies a negative relationship, thus disproving the hypothesis, and it was not found to be significant for either financial or customer-based success. While it cannot be concluded that market potential is not an important variable for either financial or customer-based success, because of the multicollinearity, given the evidence presented, hypothesis 4a is rejected.

Hypothesis 4b states that the level of competition in the market is negatively related to new product success. This is found to be true for both financial and window of opportunity success in the factor score equations, but only window of opportunity success in the variable selection equations, thus providing partial support for the hypothesis. It is not found to be significant for either customer-based success equation. However, the product-based success actually shows a positive relationship between market competitiveness and performance in the factor score models, which does not support the hypothesis. Therefore, this hypothesis is rejected.

The results for these two hypotheses, again, provide support for hypothesis 1b.

8.2.5 HYPOTHESIS 1b - DIFFERENT CRITICAL SUCCESS FACTORS

The findings presented in the last three sections all provide support for hypothesis 1b, that the importance attached to the critical success factors (c.s.f.) differs depending on the dimension of success. Given this strong supporting evidence, hypothesis 1b has not been rejected.

8.3 MANAGERIAL IMPLICATIONS/GUIDELINES

The following paragraphs attempt to summarise the practical implications from the above discussion, including some guidelines for practitioners regarding how to improve their chances of developing successful new products.

Clearly, these guidelines need to be read in light of the caveats discussed above, i.e. small sample size, multicollinearity and the problems of interpretation due to the use
of the two methods used to determine significance. More research is required before
the researcher can be more confident about the advice given. However, managers can
still use the following findings to their advantage:

1. The critical success factors differ depending on the type of success desired. Firms
can improve their chances of producing successful new products by focusing
attentions on specific NPD activities or product characteristics that are related to
the specific success dimension required.

2. In general, three of the four success dimensions identify that focusing on
undertaking the overall NPD process well does pay off. It improves the chances of
developing a successful new product for financial, customer-based and window of
opportunity success. However, while it is important to undertake all the activities
well, the variable selection model also identifies the activities that through specific
attention can further improve the chances of success. For financial success,
undertaking technical assessment well improves the likelihood of success. For
customer-based success, focusing on design and launch activities is important, and
for window of opportunity success, undertaking design and product testing
activities well is important.

3. The results for product-based success, however, show that when this success
strategy is important firms should be more cautious in assuming that simply
undertaking all activities well will improve the chances of success. The research
shows that undertaking process testing and validation activities well actually
reduces the likelihood of product-based success.

4. Out of the NPD process activities, technical assessment and design and launch
activities seem to have the greatest chance of improving the success of a product
for at least two of the success dimensions.

5. The specific types of product or non-product differentiation are different depending
on the type of success desired. It is, therefore, important to determine which type
of advantage will be effective for the product being developed.
6. Market potential is negatively related to product-based success, which means that for managers faced with markets that have low potential aiming to achieve product-based success can be a more successful strategy.

8.4 LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

In presenting the findings and drawing conclusions it should be noted that there are a number of limitations of this research. These issues are discussed below and suggestions made as to how they can be addressed by future research.

1. Firstly, it must be noted that the sample size was which can affect the findings in a number of ways. Specific differences in a single case can have a larger impact when the sample size is small. The number of cases available has also reduced the likelihood of finding significant results during the analysis stage.

2. An over ambitious questionnaire may well have reduced the response rate for the study. Therefore, reducing the length of the questionnaire would be likely to increase the response rate in any subsequent study. This could be achieved by removing the variables that were internally inconsistent, as well as those variables that had poor variability and therefore, did not discriminate very well between success and failure.

3. While it can be concluded that the nature of success measurement and the dimensions of success are not consistent with previous study findings, it is not possible to conclude that this is due to industry specific differences. Therefore, more research needs to be undertaken in other industries to confirm that the measures being used are appropriate and test the dimensions of success. This would help to determine whether the findings are industry specific, or whether similarities can be identified across groups of industries, thus, leading to generalisation.

4. Because of the problems with the small sample and multicollinearity it is not possible to conclude that those variables that did not enter each of the regression
equations are not important (see section 7.6). Further research is required to establish whether these variables are, in fact, important.

5. One rather surprising finding was that the market assessment activities, such as, determining the customer’s needs and undertaking competitor analysis, were not identified as significant variables for any of the success dimensions. One possible explanation could be that this is an industry specific finding based on the number of projects that are undertaken as joint ventures (see section 6.5.3, Chapter 6). Thus, the component suppliers are likely to be provided with much of the market information by the VM’s. This variable needs to be further tested for products that were developed in-house versus the products that were developed as joint ventures, in order to better understand whether market assessment is important.

6. Moreover, it was not possible to test all the linkages in the model (Chapter 4). Therefore, the indirect linkages, such as the effects of company characteristics on the new product strategy, the project organisation and the development process activities (shown in figure 4.1, Chapter 4), require further study to confirm whether they are significant and determine how they ultimately affect new product performance.

7. An important topic which has only received limited attention in the present investigation is the influence of various moderating variables, such as firm size, firm strategy, and project duration, on project performance. These were only assessed using bivariate correlations, therefore, the relative importance of these variables could not be determined. Future research must test these variables using correlational analysis of the differences between the success/failure groups. Linked to this is the need to confirm how these characteristics affect the individual dimensions of success, because they were only tested against overall performance during this study.

8. The model of the factors affecting new product performance developed during this research needs to be replicated so that the role of the factors as discriminators between new product success and failure and the strength of the relationship to new product performance can be confirmed. This replication will also test the
stability of the relationships established during this study, due to the estimation problems caused by the multicollinearity.

9. Related to this is the need to replicate this study in the same industry in other cultural setting, such as Europe, the US and the Far East, in order to examine cross country similarities and differences. This will help to understand the potential moderating effects of geographic region on the relationship between the factors and performance. The model also needs to be tested in other industry settings. Both these research directions will help to identify global similarities and differences in the determinants of successful new product development.

10. This study focused on one specific type of innovation, ‘genuine new products’ (see section 3.3.2, Chapter 3). Therefore, other innovation types, such as engineering applications and highly innovative ‘Blue Sky’ projects, need to be tested in order to determine whether this is a potential moderator of the relationship between the constructs and performance.

The findings from this research validate many ideas presented in the NPD literature. However, what is evident from this research is that new product success dimensions can not be treated together, and that ‘average’ models can be misleading. This may well have made it difficult for practitioners to relate the previous findings to their specific situations and could begin to explain why, despite all the research that has been undertaken, failure rates are still so high.

However, a lot more research is needed in order to better understand the interactions of the NPD process activities and how this is affected by the dimension of success. It is hoped that the findings of this study and suggestions made for future research will help both researchers and practitioners in this highly complex area of NPD.
REFERENCES


APPENDICES
APPENDIX 3.1

EXPLORATORY INTERVIEW SCHEDULE

**Business Issues**
What product sectors does your company operate in?
Is the company structured according to these product sectors, or in some other way?
What challenges are affecting your company at the present time?
- Technological changes (internal)
- Market changes (customers)
- Environmental & Safety (legislation etc.)
When do you begin communication with customers?
How are these communication links managed?

**New Product Development Types**
What sort of Product Development do you carry out?
Is this product development carried out within each division or is there one team responsible for all product development?

**Success**
Do you measure the success or failure of your individual new product development projects?
What measures of success do you currently use?
Financial/Non financial
What measures do you think would best evaluate the success or failure of the new products your organisation introduces?
Why is it that your organisation does not utilise these measures of success/failure?

**Process**
Do you follow a specific product development process/series of development stages?
What are the main stages?
What is the source of most new product ideas?
Do you undertake new product design?
From these designs do you then undertake the product development work?
How do you test and validate these developments?
How do you validate your product for the end customer? (Homologation)
What market launch capabilities are required/important?
APPENDIX 3.2

EXAMPLE OF DATA DISPLAY

FIRM 1

Corporate Characteristics

Size  - 106 business sectors
- Sales of $3.8 million worldwide (1996)
- Employees - 36,000
- 24 projects per year

Strategy - Innovation, acquisition, globalisation
- Gain competitive advantage by technological collaboration/joint venture

Types of NPD Projects

- Engineering applications are the majority
- New products are more innovative
- Blue Sky projects are undertaken at head office

Success Measures

- Mostly financial measures, e.g. profit, sales, ROI
- Customer satisfaction important for repeat business
- Also interested in quality

Project Organisation

- Formalised, but flexible development process
- Use project managers, who have a fair amount of authority
- Co-operation important, especially with customers and suppliers, including risk sharing

Source of New Product Idea

- Internal, legislation, competitors, academic institutions
- Can affect the development process

New Product Strategy

- Achieve competitive advantage through a number of means, usually aim to meet customers needs, keep costs low and quality high. “It also helps to have a good relationship with customers. This can improve your chances of getting the business”

NPD Process

- Understanding customer needs
- Having a well defined product specification prior to development
- “Our design process requires project managers to produce a report of the financial implications and a project timetable, prior to a ‘go’ decision”
- Almost always outsource prototype build because it is quite specialised
- Regular reviews of the progress against the specifications
APPENDIX 5.1

ITEMS USED TO MEASURE THE CONSTRUCTS
## MEASUREMENT ITEMS, RESPONSE FORMATS AND SELECTED SOURCES

### Key
- **# Items:** These items have been developed and used by Cooper 1979a, 1979b and Cooper and Kleinschmidt, 1986, 1993
- **## Items:** These items have been developed and used by Zirger and Maidique, 1990 and Maidique and Zirger, 1984
- **### Items:** These items have been developed and used by Griffin and Page, 1993, 1996; Hart 1992; Hultink et al., 1997
- **Case Studies:** These items are based on findings of the exploratory study
- **+ Items:** These items have been reworded on the basis of the case studies
- *** Items:** These items were negatively worded

## SECTION 1
### Product Characteristics

This product was considered to be a: Success ☐ Failure ☐  

**Cooper and de Brentani, 1991**

The product type was: ___________  

**Pugh and Morley, 1988,**  
**Mishra et al., 1996**

How long did the project take to develop from conception to launch?  

**Clark, 1989, Case Studies**

<table>
<thead>
<tr>
<th>To what extent does each statement correctly describe your product? 0 = Strongly disagree, 10 = Strongly agree</th>
</tr>
</thead>
</table>

### Product Advantage

- Compared to competitive products, this product offered some unique features or attributes to the customer  
  **#, ##, Song and Parry, 94**  
  **Kleinschmidt & Cooper 95**
- Customers' needs were better met by competing products *  
  **#, Song and Parry, 94,**  
  **Kleinschmidt & Cooper 95**
- This product was superior in terms of product quality relative to competitors  
  **#, ##, Song and Parry, 94**  
  **Kleinschmidt & Cooper 95**
- This product was highly innovative, new to the market  
  **Kleinschmidt & Cooper 95 +**
- The product used completely new technology  
  **Song and Parry, 94 & +**
- This product improved the customers' operation (product and/or process)  
  **Kleinschmidt & Cooper 95 +**
- The benefits this product provided were highly visible / easy to communicate to customers  
  **Kleinschmidt & Cooper 95**
- This product was priced lower than competitors' product  
  **#, Kleinschmidt & Cooper 95**
- This product permitted the customer to do something he could not presently do with what was available  
  **#, ##, Song and Parry, 94**
- This product provided the customer with better value for money relative to alternative products  
  **Kleinschmidt & Cooper 95,**  
  **Song and Parry, 94 & +**
- Competing products had superior technical performance *  
  **#, ##, Song and Parry, 94**

### Non-Product Advantage

- This product had a higher perceived level of technical competence vs. competitors  
  **#, Kleinschmidt & Cooper 95**
- This product had an advantage via company reputation or brand strength  
  **#, Kleinschmidt & Cooper 95**
- This product had an advantage via product availability / delivery  
  **#, Kleinschmidt & Cooper 95**
- This product had an advantage through flexibility of production volumes  
  **Case Studies**
SECTION 2
Product Development

This section looks at how the product was developed, including organisation and process activities involved in developing a product from an initial idea through to its market launch. Please respond to each of the following questions in relation to the development of your particular product.

To what extent does each statement correctly describe your project? 0 = Strongly disagree, 10 = Strongly agree.

Project Organisation

There was one person who was a strong driver and leader of the project

There was a core team, who were responsible for the project from beginning to end

There was not enough top management support for this project

The customers were actively involved in the development process

The suppliers were actively involved in the development process

The internal communications within the project team were excellent

The project manager did not have sufficient authority

The cost of the project was closely monitored

The development process was highly formalised

The project was developed as a joint venture with:

Customers Competitors Suppliers N/A

Source of New Product Idea

The source(s) of the new product idea was/were: (Tick as many as apply)

Internal to the company

Customers

Competitors

Suppliers

Other, e.g. Legislation, Another Industry, Academic Institution

Pre-development Activities

To what extent are the following statements true for the project PRIOR TO DEVELOPMENT? (Please rate ALL statements below):

Market Assessment

We understood all our potential customers' needs, wants and specifications for this product

We carried out 'end user' customer clinics to identify their potential needs and wants

We understood the market characteristics and trends for this product well

We did not know how much the customer would pay for such a product (their price sensitivity)

We knew our competitors well (e.g. their products, pricing, strategies, and strengths)

We carried out a full examination and benchmarking exercise of competitors products

The size of our potential market for this product was unknown

We knew exactly when competitor's products were going to be launched

This statement is true
To what extent are the following statements true for the project PRIOR TO DEVELOPMENT? (Please rate ALL statements below):

**Technical Assessment**

- This product’s specifications and features were very clear prior to development
- The technical problems and exactly how they would be solved, were very clear prior to development
- We knew and understood the technology behind this product well
- We had a good knowledge of the costs involved in manufacturing this product
- We had conducted preliminary engineering, technical and manufacturing assessments
- The feasibility of developing and manufacturing a product with these features had been evaluated
- We had identified all possible sourcing alternatives for component parts
- No assessment was carried out on the potential environmental risks (emissions, materials, waste, packaging, process)

**Concept Generation**

- We produced a comprehensive product design specification prior to development
- We carried out extensive modelling and prototyping before we had an agreed product design specification
- The product concept was translated into business terms (such as market share, profitability, etc.)

**Screening**

- Key business implications of the product concept and its development had been identified
- A business decision to continue with the project was made prior to development
- Overall, the initial screening of the product idea was carried out well

**Project Planning**

- A detailed timetable for the subsequent product development stages had been established
- Team member responsibilities were well defined prior to development
- Detailed milestones/goals for measuring the performance and progress for each stage of the development process had been established

To what extent are the following statements true for the project DURING DEVELOPMENT? (Please rate ALL statements below):

**Development Programme**

- We performed the engineering analysis well
- We prepared the design FMEAs well
- We completed detailed drawings before beginning any prototyping
- Extensive up-front analytic and predictive work was carried out prior to prototyping
- There was no involvement from manufacturing at the development stage
- The product design specification or outline of requirements was regularly reviewed as the design developed
- The product design specification or outline of requirements was regularly updated as the design developed
- The manufacturing process was developed in parallel with the product
- A full test and validation plan was developed at this stage, including testing methods, responsibilities, schedules, and costs
- Decisions about production sources and production assembly techniques went on in parallel with design
- We outsourced significant parts of the design process
- The FMEA was thoroughly reassessed at the end of the development process
To what extent are the following statements true for the project **DURING DEVELOPMENT**? (Please rate ALL statements below):

<table>
<thead>
<tr>
<th>Prototyping</th>
<th>Case Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>We began producing prototypes early on in the development process</td>
<td></td>
</tr>
<tr>
<td>The modelling or prototyping totally altered the product design specification</td>
<td></td>
</tr>
<tr>
<td>Customers were highly involved in prototype appraisal</td>
<td></td>
</tr>
<tr>
<td>We outsourced all the prototype building</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tooling</th>
<th>Case Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>We completed product and process designs prior to committing resources for implementation</td>
<td></td>
</tr>
<tr>
<td>Customers wanted to see full production parts early on in the development process</td>
<td></td>
</tr>
<tr>
<td>We committed to production tooling before we had fully manufactured prototypes</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Testing/Validation</th>
<th>Song &amp; Parry 94, + Case Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product</strong></td>
<td></td>
</tr>
<tr>
<td>We evaluated laboratory tests to determine the performance against specifications</td>
<td></td>
</tr>
<tr>
<td>We interpreted the findings from the in-house trials and incorporated them into product design and commercialisation plans</td>
<td></td>
</tr>
<tr>
<td>We carried out extensive product/component bench testing to determine performance against specifications</td>
<td></td>
</tr>
<tr>
<td>We carried out extensive in-vehicle testing</td>
<td></td>
</tr>
<tr>
<td>Customers were highly involved with the product testing</td>
<td></td>
</tr>
<tr>
<td>We outsourced significant parts of the testing programme</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Process/Production Validation</th>
<th>Case Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Validation of off-tool production was carried out poorly *</td>
<td></td>
</tr>
<tr>
<td>We ran capability studies to optimise the production process for this product</td>
<td>Kleinschmidt &amp; Cooper 95</td>
</tr>
<tr>
<td>We carried out employee training well</td>
<td></td>
</tr>
<tr>
<td>Several iterations of the product development process were required before we began full scale production</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Market Launch</th>
<th>Case Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>We completely satisfied our customers delivery schedule with respect to timing</td>
<td>Kleinschmidt &amp; Cooper 95</td>
</tr>
<tr>
<td>We completely satisfied our customers quality requirements</td>
<td></td>
</tr>
<tr>
<td>The product met all the legislative requirements</td>
<td></td>
</tr>
<tr>
<td>The product which entered the market was significantly different to that approved at the initial screen</td>
<td>Case Studies</td>
</tr>
</tbody>
</table>
### SECTION 3
The External Environment

The corporate and market environment within which the product is developed and launched can affect the outcome of the development project. To the best of your knowledge, please rate the following environment characteristics by circling the appropriate number.

Please rate ALL statements below:

<table>
<thead>
<tr>
<th><strong>Company Characteristics</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The following company capabilities were more than adequate for this project:</td>
</tr>
<tr>
<td>financial resources</td>
</tr>
<tr>
<td>R&amp;D/product development skills</td>
</tr>
<tr>
<td>manufacturing / production resources</td>
</tr>
<tr>
<td>management skills</td>
</tr>
<tr>
<td>market research skills</td>
</tr>
<tr>
<td>engineering skills</td>
</tr>
<tr>
<td>distribution resources</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>The Market for the Product</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential customers had a great need for this class of product</td>
</tr>
<tr>
<td>The market for this product was growing very quickly</td>
</tr>
<tr>
<td>The market size (either existing or potential) for this product was large</td>
</tr>
<tr>
<td>Competing products were very similar to each other</td>
</tr>
<tr>
<td>Non-price competition in the market was very intense</td>
</tr>
<tr>
<td>Potential customers for this product were very loyal to competitors’ products</td>
</tr>
<tr>
<td>There were many competitors in this market</td>
</tr>
<tr>
<td>There was a strong, dominant competitor in this market</td>
</tr>
<tr>
<td>Potential customers for this product were very satisfied with competitors’ products</td>
</tr>
<tr>
<td>There were barriers to entry for new competition</td>
</tr>
<tr>
<td>The market was characterised by intense price competition</td>
</tr>
</tbody>
</table>

---

#, Song & Parry 94, Kleinschmidt & Cooper 95
#, Song & Parry 94, Kleinschmidt & Cooper 95
#, Song & Parry 94, Kleinschmidt & Cooper 95
#, Song & Parry 94, Kleinschmidt & Cooper 95
#, Song & Parry 94
#, Song & Parry 94
#, Song & Parry 94
#, Song & Parry 94
#, Song & Parry 94
#, Song & Parry 94
#, Song & Parry 94
Porter 80, Case Studies
#, ##, Song & Parry 94
SECTION 4
Performance Measures

This section looks at the performance or commercial outcome of the new product chosen, to be gauged a number of different criteria. Please indicate, from what you know today, how this selected product performed using ALL the following criteria. Please circle the appropriate number.

Please rate ALL statements below:

**Performance Measures**

- The project exceeded company's profit levels
- The project exceeded margin goals
- The project exceeded break-even time
- The project exceeded Internal Rate of Return or Return on Investment goals
- The project exceeded revenue goals
- The project exceeded market share goals
- The project exceeded sales volume goals (units not revenue)
- The project exceeded the targets of customer acceptance
- The project exceeded the targets of customer satisfaction
- The project met acceptable reject levels
- The project met acceptable warranty levels
- The product exceeded the performance specifications
- The new product was considered to be a technological success
- The product opened up a "window on other opportunities" in terms of a new product category for your company
- The product opened up a "window on other opportunities" in terms of a new market opportunity for your company
- The new product was developed within the budget constraints
- The new product was ready ahead of time
- The new product was launched on time

---

Case Studies
Kleinschmidt & Cooper 87
SECTION 5
Background Information

Approximately how many employees does your company have? (Full time equivalent)

Hart 94, Mishra et al 96

Approximately what was the Turnover for your company for these years?

Rabino 80, Mishra et al. 96

Approximately what percentage of the turnover was spent on R&D/Development?

Case Study

Is your product high or low technology?
(Please circle the appropriate number)

Low Technology
Medium Technology
High Technology
1 2 3 4 5 6 7 8 9 10

Mishra et al. 96

Are the majority of your products aimed at mass markets or more specialised niche markets?
(Please tick one box)

Mass markets
A combination of mass and niche markets
Niche markets

Mishra et al. 96

Which one of the following categories best describes your company? (Please tick one box)

Griffin & Page 93

Market Driven
Driven by a combination of market and technology
Technology Driven

Griffin & Page 93, Pugh & Morley 88, Montoya-Weiss & Calantone 94

Which one of the following categories best describes your job function: (Please tick one box)

R&D/Development
Design
Marketing
Manufacturing
Other: please specify

Griffin & Page 93, Pugh & Morley 88, Montoya-Weiss & Calantone 94

Job Title: Pugh & Morley 88, Montoya-Weiss & Calantone 94

Which of the following best describes your management level?

Pugh & Morley 88, Montoya-Weiss & Calantone 94

Director
Senior Manager
Functional Manager
Product Manager
No management responsibility

Pugh & Morley 88, Montoya-Weiss & Calantone 94
APPENDIX 5.2

ORIGINAL QUESTIONNAIRE
Questionnaire

Thank you for taking the time to participate in this study into AUTOMOTIVE NEW PRODUCT DEVELOPMENT, sponsored by The Motor Industry Research Association (MIRA) and The Society of Motor Manufacturers and Traders (SMMT).

This study aims to provide an understanding of those characteristics of the NEW PRODUCT DEVELOPMENT PROCESS that are crucial to improving ultimate new project success rates.

Please fill in this questionnaire for your chosen SUCCESSFUL or FAILED new product project. Success and failure in this instance should be defined from the point of view of your company, however you measure success or failure. For the chosen project to be appropriate it should have passed through the full process of new product development from idea generation through to market launch and have been launched within the last 3 years. The development projects should not be engineering applications of an existing product to a new model, or completely new products to the company, because the latter often involve atypical development practices over longer timescales.

The contents of this questionnaire will be absolutely confidential. No commercial organisations will have access to this information, nor will the responses of individual respondents be disclosed under any circumstances.

Please use the postage paid addressed envelope provided to mail the completed questionnaire to V.M. Story, The Business School, Loughborough University, Loughborough, Leicestershire LE11 3TU. Tel. 01509 263171 Ext. 4615.

SECTION 1

Product Characteristics

This product was considered to be a: Success [ ] Failure [ ]

The generic product type was: ____________________________

How many man months and over what time duration did the project take to develop from conception to launch?

Man Months [ ] Duration [ ] Mths [ ] Yrs [ ]
<table>
<thead>
<tr>
<th>Left-hand Scale</th>
<th>Right-hand Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>To what extent does each statement correctly</strong></td>
<td><strong>HOW IMPORTANT would each of the</strong></td>
</tr>
<tr>
<td><strong>describe WHAT ACTUALLY HAPPENED</strong></td>
<td><strong>statements be in producing a SUCCESSFUL</strong></td>
</tr>
<tr>
<td><strong>during the development of this product?</strong></td>
<td><strong>OUTCOME for this product.</strong></td>
</tr>
<tr>
<td>0 = Strongly disagree, 10 = Strongly agree.</td>
<td>0 = Not important, 10 = Important</td>
</tr>
</tbody>
</table>

This example indicates that compared to competitive products, this product offered some unique features or attributes to the customer, but that this was not considered an important factor to a successful outcome.

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>Compared to competitive products, this product offered some unique features or attributes to the customer</td>
</tr>
</tbody>
</table>

Please rate ALL statements below:

### Product Advantage

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>Compared to competitive products, this product offered some unique features or attributes to the customer</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>Customers' needs were better met by competing products</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>This product was superior in terms of product quality relative to competitors</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>This product provided sustainable competitive advantage</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>This product was highly innovative, new to the market</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The product used new technology</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>This product improved the customers' operation (product or process)</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The benefits provided by this product were highly visible / easy to communicate to the customer</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>This product was priced lower than competitors' product</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>This product permitted the customer to do something he could not presently do with what was available</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>This product provided the customer with better value for money relative to alternative products</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>Competing products had superior technical performance</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>This product was planned to solve a problem the customer was having with another company's product</td>
</tr>
</tbody>
</table>

### Non-Product Advantage

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>This product had a higher perceived level of technical competence vs. competitors</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>Competing products had a service and technical support advantage over this product</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>This product had an advantage via company reputation or brand strength</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>This product had an advantage via product availability / delivery</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>This product had an advantage through flexibility of production volumes</td>
</tr>
</tbody>
</table>
SECTION 2
Product Development

This section looks at how the product was developed, including organisation and process activities involved in developing a product from an initial idea through to its market launch. Please respond to each of the following questions in relation to the development of your particular product.

<table>
<thead>
<tr>
<th>Left-hand Scale</th>
<th>Right-hand Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = Strongly disagree, 10 = Strongly agree</td>
<td>0 = Not important, 10 = Important</td>
</tr>
</tbody>
</table>

This statement is true

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>There was one person who was a strong driver and leader of the project</td>
<td>How important was this statement to a successful outcome?</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>There was a core team, who were responsible for the project from beginning to end</td>
<td>Not important</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>There was not enough top management support for this project</td>
<td>Important</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The project team mainly consisted of R&amp;D, design and manufacturing</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The customers were integrated and actively involved in the product development process</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The suppliers were integrated and actively involved in the product development process</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The internal communications within the project team were excellent</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The customers were involved in the risk sharing and management of the project</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project manager did not have sufficient authority</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project was undertaken by a cross-functional, multi-disciplinary team (from Design, R&amp;D, marketing, manufacturing etc.)</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The cost of the project was closely monitored</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The development process was highly formalised</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project was developed as a joint venture with customers</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project was developed as a joint venture with competitors/suppliers</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

Source of New Product Idea

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The source of the new product idea was internal to the company</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Customers were a source of the new product idea</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Competitors were a source of the new product idea</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Suppliers were a source of the new product idea</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Another Industry was a source of the new product idea</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Research/Academic Institutions were a source of the new product idea</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Other, please specify</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>
## Pre-development Activities

### Market Assessment

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
<th>How important was this statement to a successful outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>Not important: 0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We understood our potential customers' needs, wants and specifications for this product</td>
<td>We carried out 'end user' customer clinics to identify potential 'end user' needs and wants</td>
<td>Important: 0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We understood the market characteristics and trends for this product well</td>
<td>We did not know how much the customer would pay for such a product (their price sensitivity)</td>
<td></td>
</tr>
<tr>
<td>We knew our competitors well - their products, pricing, strategies, and strengths</td>
<td>We carried out a full examination of competitors products</td>
<td></td>
</tr>
<tr>
<td>We knew when competitors products were going to be launched</td>
<td>We carried out a full benchmarking exercise of competitors products</td>
<td></td>
</tr>
<tr>
<td>The size of our potential market for this product was unknown</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Technical Assessment

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
<th>How important was this statement to a successful outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>Not important: 0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>This product's specifications and features were very clear from the beginning of the project</td>
<td>The technical aspects and exactly how the technical problems would be solved, were very clear from the beginning of the project</td>
<td>Important: 0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We knew and understood the technology behind this product well</td>
<td>We had a good knowledge of the costs involved in manufacturing this product</td>
<td></td>
</tr>
<tr>
<td>We had conducted preliminary engineering, technical and manufacturing assessments</td>
<td>The feasibility of developing and manufacturing a product with these features had been evaluated</td>
<td></td>
</tr>
<tr>
<td>We had identified possible sourcing alternatives for component parts</td>
<td>No assessment was carried out on the potential environmental risks (emissions, materials, waste, packaging, process)</td>
<td></td>
</tr>
</tbody>
</table>

### Concept Generation

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
<th>How important was this statement to a successful outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>Not important: 0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We produced a comprehensive product design specification (PDS) at this stage</td>
<td>We did modelling and prototyping before we had agreed a product design specification (PDS)</td>
<td>Important: 0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The required benefits of the customer had been determined</td>
<td>The customers were not involved in developing the concept</td>
<td></td>
</tr>
<tr>
<td>The desired product features and their feasibility had been determined</td>
<td>The product concept had been translated into business terms (such as market share, profitability, etc.)</td>
<td></td>
</tr>
</tbody>
</table>
### This statement is true

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
</table>

To what extent are the following statements true and important for the project PRIOR TO DEVELOPMENT? (Please rate ALL statements below):

#### Screening

<table>
<thead>
<tr>
<th>0 1 2 3 4 5 6 7 8 9 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

- The key business implications of the product concept and its development had been identified
- A business decision to continue with the project was made using the estimated ROI figures
- Overall, the initial screening of the product idea was carried out well

#### Project Planning

<table>
<thead>
<tr>
<th>0 1 2 3 4 5 6 7 8 9 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

- A timetable for the subsequent product development stages had been established at this stage
- Team member responsibilities were well defined
- Milestones/goals for measuring the performance and progress for each stage of the development process had been established

### This statement is true

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
</table>

To what extent are the following statements true and important for the project DURING DEVELOPMENT? (Please rate ALL statements below):

#### Development Programme

<table>
<thead>
<tr>
<th>0 1 2 3 4 5 6 7 8 9 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

- We performed the engineering analysis well
- We prepared the design FMEAs well
- We completed detailed drawings before beginning any prototyping
- Extensive up-front analytic and predictive work was carried out prior to prototyping
- There was no involvement from manufacturing at the development stage
- The manufacturing process was developed in parallel with the product
- The product was developed on a design for manufacture basis
- The product design specification or outline of requirements was regularly reviewed as the design developed
- The product design specification or outline of requirements was regularly updated as the design developed
- A full test and validation plan was developed at this stage, including testing methods, responsibilities, schedules, and costs
- Decisions about production sources and production assembly techniques went on in parallel with design
- We outsourced significant parts of the design process
- The FMEA was reassessed at the end of the development process

### Right-hand Scale

<table>
<thead>
<tr>
<th>0 = Not important, 10 = Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

How important was this statement to a successful outcome?
<table>
<thead>
<tr>
<th>Left-hand Scale</th>
<th>Right-hand Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = Strongly disagree, 10 = Strongly agree</td>
<td>0 = Not important, 10 = Important</td>
</tr>
<tr>
<td>This statement is true</td>
<td>How important was this statement to a successful outcome</td>
</tr>
<tr>
<td><strong>Prototyping</strong></td>
<td></td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>Strongly agree</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We began producing prototypes early on in the development process</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The modelling or prototyping altered the product design specification (PDS)</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>Customers were involved in prototype appraisal</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We outsourced the building of prototypes</td>
</tr>
<tr>
<td><strong>Tooling</strong></td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We completed product and process designs prior to committing resources for implementation</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>Customers wanted to see full production parts early on in the development process</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We committed to production tooling before we had fully manufactured prototypes</td>
</tr>
<tr>
<td><strong>Testing/Validation</strong></td>
<td></td>
</tr>
<tr>
<td>Product</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We evaluated laboratory tests to determine basic performance against specifications</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We interpreted the findings from the in-house trials and incorporated them into product design and commercialisation plans</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We carried out extensive product/component bench testing</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We carried out extensive in-vehicle testing</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We submitted products to customers for in-vehicle testing</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We outsourced significant parts of the testing programme</td>
</tr>
<tr>
<td><strong>Process/Production Validation</strong></td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>Validating off-tool production was carried out poorly</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We ran capability studies to optimise the production process for this product</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We carried out employee training well</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>Further iterations of the product development process were required before we began full scale production</td>
</tr>
<tr>
<td><strong>Market Launch</strong></td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We satisfied our customers quality requirements</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We satisfied our customers on the delivery schedule with respect to timing</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The long-term production stability and capability was not verified</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The product met with all the legislative requirements</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The product which entered the market was significantly different to that approved at the initial screen i.e. the product was changed to incorporate customer's ideas or new technological breakthroughs</td>
</tr>
</tbody>
</table>
## SECTION 3

### The Company Environment

The corporate environment within which the product is developed can affect the outcome of the development project. To the best of your knowledge, please rate the Corporate Characteristics and the familiarity of the project to the firm.

<table>
<thead>
<tr>
<th>Left-hand Scale</th>
<th>Right-hand Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = Strongly disagree, 10 = Strongly agree</td>
<td>0 = Not important, 10 = Important</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
<th>How important was this statement to a successful outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The company's financial resources were more than adequate for this project</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The company's R&amp;D/product development and technical skills and resources were more than adequate for this project</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The company's market research skills and resources were more than adequate for this project</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The company's management skills and resources were more than adequate for this project</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The company's manufacturing capacity resources were more than adequate for this project</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The company's distribution resources and skills were more than adequate for this project</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The company's technical support and customer service skills and resources were more than adequate for this project</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The company's engineering resources and skills were more than adequate for this project</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>
SECTION 4
The External Environment

The external environment into which the product is launched has also been identified as impacting on product development outcomes. To the best of your knowledge, please rate the market and competitive characteristics that existed at the time the product was launched.

<table>
<thead>
<tr>
<th>This statement is true</th>
<th>How important was this statement to a successful outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not important</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

**The Market of the Product**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>The new product market mainly involved new customers to the company</td>
<td></td>
</tr>
<tr>
<td>Potential customers had a great need for this class of product</td>
<td></td>
</tr>
<tr>
<td>The market for this product was growing very quickly</td>
<td></td>
</tr>
<tr>
<td>The market size (either existing or potential) for this product was large</td>
<td></td>
</tr>
<tr>
<td>Users needs change rapidly in this market</td>
<td></td>
</tr>
</tbody>
</table>

**International Competitive Situation**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competing products were very similar to each other</td>
<td></td>
</tr>
<tr>
<td>Non-price competition in the market was very intense</td>
<td></td>
</tr>
<tr>
<td>There were many competitors in this market</td>
<td></td>
</tr>
<tr>
<td>There was a strong, dominant competitor in this market</td>
<td></td>
</tr>
<tr>
<td>Potential customers for this product were very loyal to competitors’ products in this market</td>
<td></td>
</tr>
<tr>
<td>Potential customers for this product were very satisfied with competitors’ products</td>
<td></td>
</tr>
<tr>
<td>There were barriers to entry for new producers/competitors</td>
<td></td>
</tr>
<tr>
<td>The market is characterised by intense price competition</td>
<td></td>
</tr>
</tbody>
</table>
# SECTION 5

**Performance Measures**

This section looks at the performance or commercial outcome of the new product chosen, to be gauged a number of different criteria. Please indicate, from what you know today, how this selected product performed using **ALL** the following criteria. Please circle the appropriate number.

<table>
<thead>
<tr>
<th>Left-hand Scale</th>
<th>Right-hand Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = Strongly disagree, 10 = Strongly agree</td>
<td>0 = Not important, 10 = Important</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
<th>Performance Measures</th>
<th>How important are the measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The project exceeded company's profit levels</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The project exceeded margin goals</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The project exceeded break-even time</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The project exceeded Internal Rate of Return (IRR) or Return on Investment (ROI) goals</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The project exceeded market share goals</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The project exceeded revenue goals</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The project exceeded revenue growth goals</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The project exceeded sales volume goals (units not revenue)</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The project exceeded the targets of customer acceptance</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The project exceeded the targets of customer satisfaction</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The project met acceptable reject levels</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The project met acceptable warranty levels</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The product exceeded the performance specifications</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The new product was considered to be a technological success</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The product opened up a &quot;window on other opportunities&quot; in terms of a new product category for your company</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The product opened up a &quot;window on other opportunities&quot; in terms of a new market opportunity for your company</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The new product was developed within the budget constraints</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The new product was ready ahead of time</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>The new product was launched on time</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
<tr>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
<td>This product performed well relative to the objectives set</td>
<td>0  1  2  3  4  5  6  7  8  9  10</td>
</tr>
</tbody>
</table>
**SECTION 7**

**Background Information**

These questions are included so that the information may later be categorised by product sectors, company sizes etc.

Please tick the appropriate boxes (Please approximate if you are unsure of exact figures)

<table>
<thead>
<tr>
<th>How many employees does your company have? (Full time equivalent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 100</td>
</tr>
<tr>
<td>100 - 250</td>
</tr>
<tr>
<td>251 - 500</td>
</tr>
<tr>
<td>501 - 1000</td>
</tr>
<tr>
<td>More than 1000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What was the Turnover for your company for these years?</th>
</tr>
</thead>
<tbody>
<tr>
<td>94/95</td>
</tr>
<tr>
<td>Less than £1m</td>
</tr>
<tr>
<td>£1m - £1.995m</td>
</tr>
<tr>
<td>£2m - £4.995m</td>
</tr>
<tr>
<td>£5m - £9.995m</td>
</tr>
<tr>
<td>£10m - £19.995m</td>
</tr>
<tr>
<td>£20m - £49.995m</td>
</tr>
<tr>
<td>£50m - £74.995m</td>
</tr>
<tr>
<td>£75m - £100m</td>
</tr>
<tr>
<td>More than £100m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What percentage of the turnover was spent on R&amp;D/Development?</th>
</tr>
</thead>
<tbody>
<tr>
<td>94/95</td>
</tr>
<tr>
<td>Less than 1%</td>
</tr>
<tr>
<td>2 - 3%</td>
</tr>
<tr>
<td>4 - 5%</td>
</tr>
<tr>
<td>6 - 7%</td>
</tr>
<tr>
<td>8 - 9%</td>
</tr>
<tr>
<td>More than 10%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Which one of the following categories best describes your company?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Driven</td>
</tr>
<tr>
<td>Driven by a combination of market and technology</td>
</tr>
<tr>
<td>Technology Driven</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Are the majority of your products aimed at mass markets or more specialised niche markets?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass markets</td>
</tr>
<tr>
<td>A combination of mass and niche markets</td>
</tr>
<tr>
<td>Niche markets</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Which one of the following categories best describes your job function:</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D/Development</td>
</tr>
<tr>
<td>Design</td>
</tr>
<tr>
<td>Marketing</td>
</tr>
<tr>
<td>Manufacturing</td>
</tr>
<tr>
<td>Other: please specify</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Job Title:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Which of the following best describes your management level?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director</td>
</tr>
<tr>
<td>Senior Manager</td>
</tr>
<tr>
<td>Functional Manager</td>
</tr>
<tr>
<td>Product Manager</td>
</tr>
<tr>
<td>No management responsibility</td>
</tr>
</tbody>
</table>
If you would like to receive a copy of the summary findings of this research please fill in your address below.

The findings of this research are absolutely confidential. Only summary findings will be available, individual respondents and companies will not be identified.

Thank you for taking the time to complete this questionnaire. Please use the postage paid self-addressed envelope provided to mail the completed questionnaire to V. Story, Loughborough University Business School, Loughborough, Leicestershire LE11 3TU.
APPENDIX 5.3

PRETEST LETTER
Dear

Re: Successful New Product Development by Automotive Component Suppliers

Thank you for agreeing to pre-test my questionnaire on New Product Development in automotive component suppliers. Pre-testing is a vital part of well conducted research as it ensures that the questionnaire is effective at collecting the required information.

As you are already aware, my PhD research, being undertaken at Loughborough University as part of the MIRA Business Unit, aims to identify the characteristics of a successful NPD process for European Automotive component suppliers. The questionnaire has been developed to collect information on the process by which successful and failed new products have been developed by Automotive component suppliers to identify factors which influence NPD success and failure for this market.

The purpose of asking you to pre-test the questionnaire is to ensure that the individual questions cover all the issues that can potentially impact on the development of new products, and that the overall design of the questionnaire and cover letter will be effective. Please find attached a copy of the questionnaire and cover letter.

Please could you comment on:

The cover letter - how well it explains the study and its potential to illicit a response
The questionnaire - ease of understanding, language used, logical sequence of questions, ambiguities of question or word meanings, and whether there are important questions which have been missed.

I would also be grateful if you could time yourself, or estimate the time you believe this questionnaire will take to complete.

Please find enclosed a pre-paid addressed envelope to return the questionnaire and cover letter with your comments. Please do not hesitate to contact me if you have any questions.

Thank you in anticipation of your feedback.

Yours sincerely

V.M. Story
ORIGINAL COVER LETTER
Dear

Successful New Product Development (NPD) by Automotive Component Suppliers

This is an opportunity for you to contribute to a major piece of research that aims to identify the critical factors affecting the success and failure of new products in your industry. It is based at Loughborough University Business School and is jointly funded by The Motor Industry Research Association (MIRA) and the Economic and Social Research Council (ESRC). Practical support has also provided by The Society of Motor Manufacturers and Traders Limited (SMMT).

As your contribution is critical in determining the success or failure of this research and the Ph.D, we would be extremely grateful if you could help in the completion of the attached questionnaires. As an added incentive a summary of the findings of this research will be available to those who participate. It will provide useful advice on how to enhance your NPD processes. If your company does not undertake NPD it would be appreciated if you could return the information.

The contents of this questionnaire will, of course, be absolutely confidential.

QUESTIONNAIRE COMPLETION

Enclosed are two copies of the questionnaire. They take 30 minutes to fill in. Please select two projects, one clear commercial success and one clear commercial failure, which have been developed during the past 5 years. Success and failure should be defined from the point of view of your company, however you define success or failure.

Then, forward to the person most knowledgeable about the selected project (if not yourself), e.g. the project manager, functional manager or whoever championed the project during its development, for them to complete and return in the pre-paid envelope supplied.

Thank you in anticipation of your participation in this study we very much appreciate your help in our research.

Yours sincerely

V.M. Story
APPENDIX 5.5

LETTER OF SPONSORSHIP
FROM MIRA AND SMMT
13th October 1997

Dear

Successful New Product Development (NPD) by Automotive Component Suppliers

Please find enclosed the details of a study we are sponsoring in conjunction with Loughborough University. We believe that this research will provide new insights into factors which influence NPD success and failure for the UK Automotive Components Industry. Identical surveys are being conducted in Italy and Germany.

Your company has a valuable contribution to make by completing and returning this questionnaire. An analysis of the assembled experience of sufficient companies that are actively developing new products will expose a rich picture of New Product Development practice. We would be pleased to provide a copy of the summary findings of this research to your organisation if you enter your address details on the returned questionnaire. We ask that you help us progress this important study for our industry by making an early reply.

We recommend this study to you and request that you pass this information on to the person who has a responsibility for New Product Development/R&D in your organisation.

Yours sincerely,

J.R. Wood
Managing Director
MIRA

M. Hollingsworth
Head of Policy
SMMT
APPENDIX 5.6

QUESTIONNAIRE FOR PILOT 1
Questionnaire

Thank you for taking the time to participate in this study into AUTOMOTIVE NEW PRODUCT DEVELOPMENT, sponsored by The Motor Industry Research Association (MIRA) and The Society of Motor Manufacturers and Traders (SMMT).

This study aims to provide an understanding of those characteristics of the NEW PRODUCT DEVELOPMENT PROCESS that are crucial to improving ultimate new project success rates.

Please fill in this questionnaire for your chosen SUCCESSFUL or FAILED new product project. Success and failure in this instance should be defined from the point of view of your company, however you measure success or failure. For the chosen project to be appropriate it should have passed through the full process of new product development from idea generation through to market launch and have been launched within the last 3 years. The development projects should not be engineering applications of an existing product to a new model, or completely new products to the company, because the latter often involve atypical development practices over longer timescales.

The contents of this questionnaire will be absolutely confidential. No commercial organisations will have access to this information, nor will the responses of individual respondents be disclosed under any circumstances.

Please use the postage paid addressed envelope provided to mail the completed questionnaire to V.M. Story, The Business School, Loughborough University, Loughborough, Leicestershire LE11 3TU. Tel. 01509 263171 Ext. 4615.

SECTION 1

Product Characteristics

This product was considered to be a:

Success

Failure

The generic product type was: __________________________

How many man months and over what time duration did the project take to develop from conception to launch? __________________________
This example indicates that compared to competitive products, this product offered some unique features or attributes to the customer, but that this was not considered an important factor to a successful outcome.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compared to competitive products, this product offered some unique features or attributes to the customer</td>
<td>9</td>
</tr>
<tr>
<td>Customers' needs were better met by competing products</td>
<td>0</td>
</tr>
<tr>
<td>This product was superior in terms of product quality relative to competitors</td>
<td>0</td>
</tr>
<tr>
<td>This product was highly innovative, new to the market</td>
<td>0</td>
</tr>
<tr>
<td>The product used new technology</td>
<td>0</td>
</tr>
<tr>
<td>This product improved the customers' operation (product and/or process)</td>
<td>0</td>
</tr>
<tr>
<td>The benefits provided by this product were highly visible / easy to communicate to the customer</td>
<td>0</td>
</tr>
<tr>
<td>This product was priced lower than competitors' product</td>
<td>0</td>
</tr>
<tr>
<td>This product permitted the customer to do something he could not presently do with what was available</td>
<td>0</td>
</tr>
<tr>
<td>This product provided the customer with better value for money relative to alternative products</td>
<td>0</td>
</tr>
<tr>
<td>Competing products had superior technical performance</td>
<td>0</td>
</tr>
</tbody>
</table>

**Product Advantage**

**Non-Product Advantage**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>This product had a higher perceived level of technical competence vs. competitors</td>
<td>10</td>
</tr>
<tr>
<td>This product had an advantage via company reputation or brand strength</td>
<td>10</td>
</tr>
<tr>
<td>This product had an advantage via product availability / delivery</td>
<td>10</td>
</tr>
<tr>
<td>This product had an advantage through flexibility of production volumes</td>
<td>10</td>
</tr>
</tbody>
</table>
**Product Development**

This section looks at how the product was developed, including organisation and process activities involved in developing a product from an initial idea through to its market launch. Please respond to each of the following questions in relation to the development of your particular product.

<table>
<thead>
<tr>
<th>Left-hand Scale</th>
<th>Right-hand Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = Strongly disagree, 10 = Strongly agree</td>
<td>0 = Not important, 10 = Important</td>
</tr>
</tbody>
</table>

Please rate ALL statements below:

### Project Organisation

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
<th>How important was this statement to a successful outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

- There was one person who was a strong driver and leader of the project
- There was a core team, who were responsible for the project from beginning to end
- There was not enough top management support for this project
- The project team mainly consisted of R&D, design and manufacturing
- The customers were actively involved in the product development process
- The suppliers were actively involved in the product development process
- The internal communications within the project team were excellent
- The customers were involved in the risk sharing and management of the project
- The project manager did not have sufficient authority
- The cost of the project was closely monitored
- The development process was highly formalised
- The project was developed as a joint venture with customers
- The project was developed as a joint venture with competitors/suppliers
Please rate ALL statements below:

Source of New Product Idea

The source of the new product idea was
- internal to the company
- Customers
- Competitors
- Suppliers
- Other, Legislation, Another Industry, Research/Academic Institutions

Please specify ________________________________

Pre-development Activities

To what extent are the following statements true and important for the project PRIOR TO DEVELOPMENT? (Please rate ALL statements below):

Market Assessment

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

We understood our potential customers' needs, wants and specifications for this product
We carried out 'end user' customer clinics to identify potential 'end user' needs and wants
We understood the market characteristics and trends for this product well
We did not know how much the customer would pay for such a product (their price sensitivity)
We knew our competitors well - their products, pricing, strategies, and strengths
We carried out a full examination of competitors products
We carried out a full benchmarking exercise of competitors products
The size of our potential market for this product was unknown
We knew when competitors products were going to be launched

Technical Assessment

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

This product's specifications and features were very clear from the beginning of the project
The technical aspects and exactly how the technical problems would be solved, were very clear from the beginning of the project
We knew and understood the technology behind this product well
To what extent are the following statements true and important for the project PRIOR TO DEVELOPMENT? (Please rate ALL statements below):

**Market and Technical Assessment (Cont.)**

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

- **We had a good knowledge of the costs involved in manufacturing this product**
- **We had conducted preliminary engineering, technical and manufacturing assessments**
- **The feasibility of developing and manufacturing a product with these features had been evaluated**
- **We had identified possible sourcing alternatives for component parts**
- **No assessment was carried out on the potential environmental risks (emissions, materials, waste, packaging, process)**

**Concept Generation**

<table>
<thead>
<tr>
<th>0 1 2 3 4 5 6 7 8 9 10</th>
</tr>
</thead>
</table>

- **We produced a comprehensive product design specification (PDS) at this stage**
- **We did modelling and prototyping before we had agreed a product design specification (PDS)**
- **The customers were not involved in developing the concept**
- **The product concept had been translated into business terms (such as market share, profitability, etc.)**

**Screening**

<table>
<thead>
<tr>
<th>0 1 2 3 4 5 6 7 8 9 10</th>
</tr>
</thead>
</table>

- **The key business implications of the product concept and its development had been identified**
- **A business decision to continue with the project was made using the estimated ROI figures**
- **Overall, the initial screening of the product idea was carried out well**

**Project Planning**

<table>
<thead>
<tr>
<th>0 1 2 3 4 5 6 7 8 9 10</th>
</tr>
</thead>
</table>

- **A detailed timetable for the subsequent product development stages had been established at this stage**
- **Team member responsibilities were well defined**
- **Detailed milestones/goals for measuring the performance and progress for each stage of the development process had been established**
### Development Programme

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We performed the engineering analysis well</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We prepared the design FMEAs well</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We completed detailed drawings before beginning any prototyping</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>Extensive up-front analytic and predictive work was carried out prior to prototyping</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>There was no involvement from manufacturing at the development stage</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The manufacturing process was developed in parallel with the product</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The product design specification or outline of requirements was regularly reviewed as the design developed</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The product design specification or outline of requirements was regularly updated as the design developed</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>A full test and validation plan was developed at this stage, including testing methods, responsibilities, schedules, and costs</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>Decisions about production sources and production assembly techniques went on in parallel with design</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>We outsourced significant parts of the design process</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The FMEA was reassessed at the end of the development process</td>
<td></td>
</tr>
</tbody>
</table>

### Prototyping

| 0 1 2 3 4 5 6 7 8 9 10 | We began producing prototypes early on in the development process |
| 0 1 2 3 4 5 6 7 8 9 10 | The modelling or prototyping altered the product design specification (PDS) |
| 0 1 2 3 4 5 6 7 8 9 10 | Customers were involved in prototype appraisal |
| 0 1 2 3 4 5 6 7 8 9 10 | We outsourced all the building of prototypes |

### Tooling

<p>| 0 1 2 3 4 5 6 7 8 9 10 | We completed product and process designs prior to committing resources for implementation |
| 0 1 2 3 4 5 6 7 8 9 10 | Customers wanted to see full production parts early on in the development process |
| 0 1 2 3 4 5 6 7 8 9 10 | We committed to production tooling before we had fully manufactured prototypes |</p>
<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

**Test/Validation**

- **Product**
  - 0 1 2 3 4 5 6 7 8 9 10: We evaluated laboratory tests to determine basic performance against specifications
  - 0 1 2 3 4 5 6 7 8 9 10: We interpreted the findings from the in-house trials and incorporated them into product design and commercialisation plans
  - 0 1 2 3 4 5 6 7 8 9 10: We carried out extensive product/component bench testing to determine performance against specifications
  - 0 1 2 3 4 5 6 7 8 9 10: We carried out extensive in-vehicle testing
  - 0 1 2 3 4 5 6 7 8 9 10: Customers were highly involved with the product testing
  - 0 1 2 3 4 5 6 7 8 9 10: We outsourced significant parts of the testing programme

- **Process/Production Validation**
  - 0 1 2 3 4 5 6 7 8 9 10: Validating off-tool production was carried out poorly
  - 0 1 2 3 4 5 6 7 8 9 10: We ran capability studies to optimise the production process for this product
  - 0 1 2 3 4 5 6 7 8 9 10: We carried out employee training well
  - 0 1 2 3 4 5 6 7 8 9 10: Several iterations of the product development process were required before we began full scale production

**Market Launch**

- 0 1 2 3 4 5 6 7 8 9 10: We satisfied our customers on the delivery schedule with respect to timing
- 0 1 2 3 4 5 6 7 8 9 10: We satisfied our customers quality requirements
- 0 1 2 3 4 5 6 7 8 9 10: The product met all the legislative requirements
- 0 1 2 3 4 5 6 7 8 9 10: The product which entered the market was significantly different to that approved at the initial screen
SECTION 3
The External Environment

The corporate, market and competitive environment within which the product is developed and launched can affect the outcome of the development project. To the best of your knowledge, please rate the following environment characteristics.

<table>
<thead>
<tr>
<th>Left-hand Scale</th>
<th>Right-hand Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = Strongly disagree, 10 = Strongly agree</td>
<td>0 = Not important, 10 = Important</td>
</tr>
<tr>
<td><strong>This statement is true</strong></td>
<td><strong>How important was this statement to a successful outcome</strong></td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>Strongly agree</td>
</tr>
<tr>
<td>The following company capabilities were more than adequate for this project</td>
<td></td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>financial resources</td>
<td>R&amp;D/product development skills</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>manufacturing / production resources</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>management skills</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>market research skills</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>engineering skills</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>distribution resources</td>
</tr>
</tbody>
</table>

| The Market of the Product | |
|---------------------------|---|---|
| 0 1 2 3 4 5 6 7 8 9 10 | Most of the competitors faced in the market were new to the company | 0 1 2 3 4 5 6 7 8 9 10 |
| 0 1 2 3 4 5 6 7 8 9 10 | The market for this product was growing very quickly | 0 1 2 3 4 5 6 7 8 9 10 |
| 0 1 2 3 4 5 6 7 8 9 10 | The market size (either existing or potential) for this product was large | 0 1 2 3 4 5 6 7 8 9 10 |

| International Competitive Situation | |
|-----------------------------------|---|---|
| 0 1 2 3 4 5 6 7 8 9 10 | Competing products were very similar to each other | 0 1 2 3 4 5 6 7 8 9 10 |
| 0 1 2 3 4 5 6 7 8 9 10 | Non-price competition in the market was very intense | 0 1 2 3 4 5 6 7 8 9 10 |
| 0 1 2 3 4 5 6 7 8 9 10 | There were many competitors in this market | 0 1 2 3 4 5 6 7 8 9 10 |
| 0 1 2 3 4 5 6 7 8 9 10 | There was a strong, dominant competitor in this market | 0 1 2 3 4 5 6 7 8 9 10 |
| 0 1 2 3 4 5 6 7 8 9 10 | Potential customers for this product were very loyal to competitors' products in this market | 0 1 2 3 4 5 6 7 8 9 10 |
| 0 1 2 3 4 5 6 7 8 9 10 | Potential customers for this product were very satisfied with competitors' products | 0 1 2 3 4 5 6 7 8 9 10 |
| 0 1 2 3 4 5 6 7 8 9 10 | There were barriers to entry for new producers/competitors | 0 1 2 3 4 5 6 7 8 9 10 |
| 0 1 2 3 4 5 6 7 8 9 10 | The market is characterised by intense price competition | 0 1 2 3 4 5 6 7 8 9 10 |
SECTION 5
Performance Measures

This section looks at the performance or commercial outcome of the new product chosen, to be gauged a number of different criteria. Please indicate, from what you know today, how this selected product performed using ALL the following criteria. Please circle the appropriate number.

<table>
<thead>
<tr>
<th>This statement is true</th>
<th>Please rate ALL statements below:</th>
<th>How important was this statement to a successful outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree</td>
<td>Strongly agree</td>
<td>Not important</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The project exceeded company's profit levels</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The project exceeded margin goals</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The project exceeded break-even time</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The project exceeded Internal Rate of Return (IRR) or Return on Investment (ROI) goals</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The project exceeded market share goals</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The project exceeded revenue goals</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The project exceeded sales volume goals (units not revenue)</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The project exceeded the targets of customer acceptance</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The project exceeded the targets of customer satisfaction</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The project met acceptable reject levels</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The project met acceptable warranty levels</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The product exceeded the performance specifications</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The new product was considered to be a technological success</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The product opened up a &quot;window on other opportunities&quot; in terms of a new product category for your company</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The product opened up a &quot;window on other opportunities&quot; in terms of a new market opportunity for your company</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The new product was developed within the budget constraints</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The new product was ready ahead of time</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>The new product was launched on time</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>
SECTION 7
Background Information

These questions are included so that the information may later be categorised by product sectors, company sizes etc.
Please tick the appropriate boxes (Please approximate if you are unsure of exact figures)

Approximately how many employees does your company have? (Full time equivalent)

---

Approximately what was the Turnover for your company for these years?
95/96 ---
96/97 ---

Approximately what percentage of the turnover was spent on R&D/Development?
95/96 ---
96/97 ---

Is your product high or low technology?

Low  Medium  High
Technology  1  2  3  4  5  6  7  8  9  10

Are the majority of your products aimed at mass markets or more specialised niche markets?

Mass markets  A combination of mass and niche markets  Niche markets

---

Which one of the following categories best describes your company?

Market Driven
Driven by a combination of market and technology
Technology Driven

Which one of the following categories best describes your job function:

R&D/Development
Design
Marketing
Manufacturing
Other: please specify

---

Job Title: --------

Which of the following best describes your management level?

Director
Senior Manager
Functional Manager
Product Manager
No management responsibility

---
If you would like to receive a copy of the summary findings of this research please fill in your details below.

The findings of this research are absolutely confidential. Only summary findings will be available, individual respondents and companies will not be identified.

Thank you for taking the time to complete this questionnaire. Please use the postage paid self-addressed envelope provided to mail the completed questionnaire to V. Story, Loughborough University Business School, Loughborough, Leicestershire LE11 3TU.
APPENDIX 5.7

QUESTIONNAIRE FOR PILOT 2
Successful New Product Development for Automotive Component Suppliers

- All responses will be treated in the strictest confidence
- The questionnaire takes 30 minutes to fill in and we would be extremely grateful if you could complete it as your contribution is critical to the success of this research.
- A summary of the findings will be available to those who participate by filling in the last section of the questionnaire.

Please fill in this questionnaire for your chosen SUCCESSFUL or FAILED new product project. Success and failure should be defined from the point of view of your company, however you measure success or failure. The project must have passed through the full process of new product development from idea generation through to market launch and have been launched within the last 5 years. It should not be completely new products to the company, because these often involve atypical development practices over longer timescales, or engineering applications of an existing product to a new model.

Please return the completed questionnaire in the freepost envelope supplied

Thank you for your help
SECTION 1
Product Characteristics

This product was considered to be a: Success ☐ Failure ☐ (Please tick one box)

The product type was: ____________________________________________________________
e.g. Braking components, Exhaust systems, HVAC components, Seating etc.

How long did the project take to develop from conception to launch?

To what extent does each statement correctly describe your product? 0 = Strongly disagree, 10 = Strongly agree. Please circle the appropriate number.

Please rate ALL statements below:

Product Advantage

Compared to competitive products, this product offered some unique features or attributes to the customer

Customers' needs were better met by competing products

This product was superior in terms of product quality relative to competitors

This product was highly innovative, new to the market

The product used completely new technology

This product improved the customers' operation (product and/or process)

The benefits this product provided were highly visible / easy to communicate to customers

This product was priced lower than competitors' product

This product permitted the customer to do something he could not presently do with what was available

This product provided the customer with better value for money relative to alternative products

Competing products had superior technical performance

Non-Product Advantage

This product had a higher perceived level of technical competence vs. competitors

This product had an advantage via company reputation or brand strength

This product had an advantage via product availability / delivery

This product had an advantage through flexibility of production volumes

Duration

Yrs Mths

This statement is true

Strongly disagree Strongly agree

0 1 2 3 4 5 6 7 8 9 10

0 1 2 3 4 5 6 7 8 9 10

0 1 2 3 4 5 6 7 8 9 10

0 1 2 3 4 5 6 7 8 9 10

0 1 2 3 4 5 6 7 8 9 10

0 1 2 3 4 5 6 7 8 9 10

0 1 2 3 4 5 6 7 8 9 10

0 1 2 3 4 5 6 7 8 9 10

0 1 2 3 4 5 6 7 8 9 10

0 1 2 3 4 5 6 7 8 9 10
SECTION 2
Product Development

This section looks at how the product was developed, including organisation and process activities involved in developing a product from an initial idea through to its market launch. Please respond to each of the following questions in relation to the development of your particular product.

To what extent does each statement correctly describe your project? 0 = Strongly disagree, 10 = Strongly agree. Please circle the appropriate number.

Please rate ALL statements below:

Project Organisation

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>There was one person who was a strong driver and leader of the project</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>There was a core team, who were responsible for the project from beginning to end</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>There was not enough top management support for this project</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The customers were actively involved in the development process</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The suppliers were actively involved in the development process</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The internal communications within the project team were excellent</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project manager did not have sufficient authority</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The cost of the project was closely monitored</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The development process was highly formalised</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project was developed as a joint venture with:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customers [ ] Competitors [ ] Suppliers [ ] N/A [ ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source of New Product Idea

The source(s) of the new product idea was/were: (Tick as many as apply)

- Internal to the company
- Customers
- Competitors
- Suppliers
- Other, e.g. Legislation, Another Industry, Academic Institution

Pre-development Activities

To what extent are the following statements true for the project PRIOR TO DEVELOPMENT? (Please rate ALL statements below):

Market Assessment

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>We understood all our potential customers' needs, wants and specifications for this product</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We carried out 'end user' customer clinics to identify their potential needs and wants</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We understood the market characteristics and trends for this product well</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We did not know how much the customer would pay for such a product (their price sensitivity)</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We knew our competitors well (e.g. their products, pricing, strategies, and strengths)</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We carried out a full examination and benchmarking exercise of competitors products</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The size of our potential market for this product was unknown</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We knew exactly when competitor's products were going to be launched</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>
To what extent are the following statements true for the project PRIOR TO DEVELOPMENT? (Please rate ALL statements below):

### Technical Assessment

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>This product’s specifications and features were very clear prior to development</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The technical problems and exactly how they would be solved, were very clear prior to development</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We knew and understood the technology behind this product well</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We had a good knowledge of the costs involved in manufacturing this product</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We had conducted preliminary engineering, technical and manufacturing assessments</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The feasibility of developing and manufacturing a product with these features had been evaluated</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We had identified all possible sourcing alternatives for component parts</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>No assessment was carried out on the potential environmental risks (emissions, materials, waste, packaging, process)</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

### Concept Generation

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>We produced a comprehensive product design specification prior to development</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We carried out extensive modelling and prototyping before we had an agreed product design specification</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The product concept was translated into business terms (such as market share, profitability, etc.)</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

### Screening

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key business implications of the product concept and its development had been identified</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>A business decision to continue with the project was made prior to development</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Overall, the initial screening of the product idea was carried out well</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

### Project Planning

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>A detailed timetable for the subsequent product development stages had been established</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Team member responsibilities were well defined prior to development</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Detailed milestones/goals for measuring the performance and progress for each stage of the development process had been established</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

To what extent are the following statements true for the project DURING DEVELOPMENT? (Please rate ALL statements below):

### Development Programme

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>We performed the engineering analysis well</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We prepared the design FMEAs well</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We completed detailed drawings before beginning any prototyping</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Extensive up-front analytic and predictive work was carried out prior to prototyping</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>There was no involvement from manufacturing at the development stage</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The product design specification or outline of requirements was regularly reviewed as the design developed</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The product design specification or outline of requirements was regularly updated as the design developed</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The manufacturing process was developed in parallel with the product</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>A full test and validation plan was developed at this stage, including testing methods, responsibilities, schedules, and costs</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Decisions about production sources and production assembly techniques went on in parallel with design</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We outsourced significant parts of the design process</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The FMEA was thoroughly reassessed at the end of the development process</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>
To what extent are the following statements true for the project during development? (Please rate ALL statements below):

**Prototyping**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>We began producing prototypes early on in the development process</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The modelling or prototyping totally altered the product design specification</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Customers were highly involved in prototype appraisal</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We outsourced all the prototype building</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>We completed product and process designs prior to committing resources for implementation</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Customers wanted to see full production parts early on in the development process</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We committed to production tooling before we had fully manufactured prototypes</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

**Testing/Validation**

**Product**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>We evaluated laboratory tests to determine the performance against specifications</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We interpreted the findings from the in-house trials and incorporated them into product design and commercialisation plans</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We carried out extensive product/component bench testing to determine performance against specifications</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We carried out extensive in-vehicle testing</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Customers were highly involved with the product testing</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We outsourced significant parts of the testing programme</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

**Process/Production Validation**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Validation of off-tool production was carried out poorly</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We ran capability studies to optimise the production process for this product</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We carried out employee training well</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Several iterations of the product development process were required before we began full scale production</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

**Market Launch**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>We completely satisfied our customers delivery schedule with respect to timing</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We completely satisfied our customers quality requirements</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The product met all the legislative requirements</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The product which entered the market was significantly different to that approved at the initial screen</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

**SECTION 3**

**The External Environment**

The corporate and market environment within which the product is developed and launched can affect the outcome of the development project. To the best of your knowledge, please rate the following environment characteristics by circling the appropriate number.

Please rate ALL statements below:

**Company Characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>financial resources</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>R&amp;D/product development skills</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>manufacturing / production resources</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>management skills</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>market research skills</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>engineering skills</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>distribution resources</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>
Please rate ALL statements below:

**The Market for the Product**

<table>
<thead>
<tr>
<th>Potential customers had a great need for this class of product</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The market for this product was growing very quickly</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The market size (either existing or potential) for this product was large</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Competing products were very similar to each other</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Non-price competition in the market was very intense</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Potential customers for this product were very loyal to competitors’ products</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>There were many competitors in this market</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>There was a strong, dominant competitor in this market</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Potential customers for this product were very satisfied with competitors’ products</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>There were barriers to entry for new competition</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The market was characterised by intense price competition</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

**SECTION 4
Performance Measures**

This section looks at the performance or commercial outcome of the new product chosen, to be gauged a number of different criteria. Please indicate, from what you know today, how this selected product performed using ALL the following criteria. Please circle the appropriate number.

Please rate ALL statements below:

**Performance Measures**

<table>
<thead>
<tr>
<th>The project exceeded company's profit levels</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The project exceeded margin goals</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project exceeded break-even time</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project exceeded Internal Rate of Return or Return on Investment goals</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project exceeded revenue goals</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project exceeded market share goals</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project exceeded sales volume goals (units not revenue)</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project exceeded the targets of customer acceptance</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project exceeded the targets of customer satisfaction</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project met acceptable reject levels</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project met acceptable warranty levels</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The product exceeded the performance specifications</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The new product was considered to be a technological success</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The product opened up a &quot;window on other opportunities&quot; in terms of a new product category for your company</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The product opened up a &quot;window on other opportunities&quot; in terms of a new market opportunity for your company</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The new product was developed within the budget constraints</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The new product was ready ahead of time</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The new product was launched on time</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

Was your product rated against any other measures of performance?  
Yes [ ] No [ ]

If Yes, please specify and rate:

<table>
<thead>
<tr>
<th>This statement is true</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>
SECTION 5
Background Information

Approximately how many employees does your company have? (Full time equivalent)

Approximately what was the Turnover for your company for these years?

<table>
<thead>
<tr>
<th>Year</th>
<th>Turnover</th>
</tr>
</thead>
<tbody>
<tr>
<td>95/96</td>
<td></td>
</tr>
<tr>
<td>96/97</td>
<td></td>
</tr>
</tbody>
</table>

Approximately what percentage of the turnover was spent on R&D/Development?

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>95/96</td>
<td></td>
</tr>
<tr>
<td>96/97</td>
<td></td>
</tr>
</tbody>
</table>

Is your product high or low technology?
(Please circle the appropriate number)

Low Technology

1 2 3 4 5 6 7 8 9 10

High Technology

Which one of the following categories best describes your company? (Please tick one box)

Market Driven

Driven by a combination of market and technology

Technology Driven

Which one of the following categories best describes your job function? (Please tick one box)

R&D/Development

Design

Marketing

Manufacturing

Other: please specify

Job Title: ____________________________________________

Are the majority of your products aimed at mass markets or more specialised niche markets?
(Please tick one box)

Mass markets

A combination of mass and niche markets

Niche markets

Which of the following best describes your management level?

Director

Senior Manager

Functional Manager

Product Manager

No management responsibility

If you would like to receive a copy of the summary findings of this research please fill in your name and address below:

The findings of this research are absolutely confidential. Only summary findings will be available, individual respondents and companies will not be identified.

Thank you for your help
APPENDIX 5.8

COVER LETTER FOR MAIN STUDY
Dear 

Successful New Product Development (NPD) for Automotive Component Suppliers

I am a PhD student at Loughborough University sponsored by The Motor Industry Research Association, MIRA and aided by the Society of Motor Manufacturers and Traders (SMMT). The objective of my study is to identify the critical factors affecting the success and failure of new products in your industry.

As your company has an excellent reputation for New Product Development I would be extremely grateful if you could spare some time to complete the enclosed questionnaires, one for a commercial success and one for a commercial failure. A summary of my research's findings will be available on completion of my PhD by filling in your name and address in the space provided. This will enable you to compare your Company's performance with the results of the industry sample in key strategic areas.

If you feel that somebody else in your company may be in a better position to answer I would appreciate it if you could pass this information onto him/her. If this is not possible, please could you return the information in the pre-paid envelope supplied.

All information supplied will remain absolutely confidential.

Your co-operation will be greatly appreciated and I would be pleased to discuss the research with you in more detail if you would find this helpful.

Yours sincerely

V.M. Story
Successful New Product Development for Automotive Component Suppliers

- All responses will be treated in the strictest confidence
- A summary of the findings will be available to those who participate by filling in the last section of the questionnaire.
- The questionnaire takes no more than 30 minutes to fill in and I would be extremely grateful if you could complete it as your contribution is critical to the success of this research.

Please fill in this questionnaire for your chosen SUCCESSFUL or FAILED new product project. Success and failure should be defined from the point of view of your company, however you measure success or failure. The project should have passed through the full process of new product development from idea generation through to market launch and have been launched within the last 5 years. It should not be completely new products to the company, because these often involve atypical development practices over longer timescales, or minor engineering applications of an existing product.

Please return the completed questionnaire in the freepost envelope supplied

Thank you for your help
SECTION 1
Product Characteristics

This product was considered to be a: Success ☐ Failure ☐ (Please tick one box)

The product type was: ________________________________
(e.g. Braking components, Exhaust systems, HVAC components, Seating etc.)

Duration

Yrs Mths

How long did the project take to develop from conception to launch?

To what extent does each statement correctly describe your product? 0 = Strongly disagree, 10 = Strongly agree. Please circle the appropriate number.

Please rate ALL statements below:

<table>
<thead>
<tr>
<th>Product Advantage</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compared to competitive products, this product offered some unique features or attributes to the customer</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Customers’ needs were better met by competing products</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>This product was superior in terms of product quality relative to competitors</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>This product was highly innovative, new to the market</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The product used completely new technology</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>This product improved the customers’ operation (product and/or process)</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The benefits this product provided were highly visible / easy to communicate to customers</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>This product was priced lower than competitors’ product</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>This product permitted the customer to do something he could not presently do with what was available</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>This product provided the customer with better value for money relative to alternative products</td>
<td>0 1 2 3 4 5 6 7 8 10</td>
<td></td>
</tr>
<tr>
<td>Competing products had superior technical performance</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non- Product Advantage</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>This product had a higher perceived level of technical competence vs. competitors</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>This product had an advantage via company reputation or brand strength</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>This product had an advantage via product availability / delivery</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>This product had an advantage through flexibility of production volumes</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>
SECTION 2
Product Development

This section looks at how the product was developed, including organisation and process activities involved in developing a product from an initial idea through to its market launch. Please respond to each of the following questions in relation to the development of your particular product.

<table>
<thead>
<tr>
<th>To what extent does each statement correctly describe your project? 0 = Strongly disagree, 10 = Strongly agree. Please circle the appropriate number.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Organisation</strong></td>
</tr>
<tr>
<td>There was one person who was a strong driver and leader of</td>
</tr>
<tr>
<td>the project</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>There was a core team, who were responsible for the project</td>
</tr>
<tr>
<td>from beginning to end</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>There was not enough top management support for this project</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The customers were actively involved in the development</td>
</tr>
<tr>
<td>process</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The suppliers were actively involved in the development</td>
</tr>
<tr>
<td>process</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The internal communications within the project team were</td>
</tr>
<tr>
<td>excellent</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The project manager did not have sufficient authority</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The cost of the project was closely monitored</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The development process was highly formalised</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The project was developed as a joint venture with:</td>
</tr>
<tr>
<td>Customers [ ] Competitors [ ] Suppliers [ ] N/A [ ]</td>
</tr>
<tr>
<td>(Tick as many as apply)</td>
</tr>
</tbody>
</table>

| **Source of New Product Idea**                                |
| The source(s) of the new product idea was/were: (Tick as    |
| many as apply)                                               |
| Internal to the company [ ]                                   |
| Customers [ ]                                                 |
| Competitors [ ]                                               |
| Suppliers [ ]                                                 |
| Other, e.g. Legislation, Another Industry, Academic         |
| Institution [ ]                                               |
| Please specify                                                |

| **Pre-development Activities**                               |
| To what extent are the following statements true for the    |
| project PRIOR TO DEVELOPMENT? (Please rate ALL statements     |
| below):                                                      |
| **Market Assessment**                                        |
| We understood all our potential customers’ needs, wants and |
| specifications for this product                              |
| 0 1 2 3 4 5 6 7 8 9 10                                       |
| We carried out ‘end user’ customer clinics to identify      |
| their potential needs and wants                              |
| 0 1 2 3 4 5 6 7 8 9 10                                       |
| We understood the market characteristics and trends for the |
| product well                                                 |
| 0 1 2 3 4 5 6 7 8 9 10                                       |
| We did not know how much the customer would pay for such a  |
| product (their price sensitivity)                            |
| 0 1 2 3 4 5 6 7 8 9 10                                       |
| We knew our competitors well (e.g. their products, pricing, |
| strategies, and strengths)                                  |
| 0 1 2 3 4 5 6 7 8 9 10                                       |
| We carried out a full examination and benchmarking         |
| exercise of competitors products                             |
| 0 1 2 3 4 5 6 7 8 9 10                                       |
| The size of our potential market for this product was       |
| unknown                                                      |
| 0 1 2 3 4 5 6 7 8 9 10                                       |
| We knew exactly when competitor’s products were going to    |
| be launched                                                  |
| 0 1 2 3 4 5 6 7 8 9 10                                       |
To what extent are the following statements true for the project **PRIOR TO DEVELOPMENT**? (Please rate ALL statements below):

### Technical Assessment

<table>
<thead>
<tr>
<th>This statement is true</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>This product's specifications and features were very clear prior to development</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The technical problems and exactly how they would be solved, were very clear prior to development</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We knew and understood the technology behind this product well</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We had a good knowledge of the costs involved in manufacturing this product</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We had conducted preliminary engineering, technical and manufacturing assessments</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The feasibility of developing and manufacturing a product with these features had been evaluated</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We had identified all possible sourcing alternatives for component parts</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>No assessment was carried out on the potential environmental risks (emissions, materials, waste, packaging, process)</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

### Concept Generation

<table>
<thead>
<tr>
<th>This statement is true</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>We produced a comprehensive product design specification prior to development</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We carried out extensive modelling and prototyping before we had an agreed product design specification</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The product concept was translated into business terms (such as market share, profitability, etc.)</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

### Screening

<table>
<thead>
<tr>
<th>This statement is true</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key business implications of the product concept and its development had been identified</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>A business decision to continue with the project was made prior to development</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Overall, the initial screening of the product idea was carried out well</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

### Project Planning

<table>
<thead>
<tr>
<th>This statement is true</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>A detailed timetable for the subsequent product development stages had been established</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Team member responsibilities were well defined prior to development</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Detailed milestones/goals for measuring the performance and progress for each stage of the development process had been established</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

To what extent are the following statements true for the project **DURING DEVELOPMENT**? (Please rate ALL statements below):

### Development Programme

<table>
<thead>
<tr>
<th>This statement is true</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>We performed the engineering analysis well</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We prepared the design FMEAs well</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We completed detailed drawings before beginning any prototyping</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Extensive up-front analytic and predictive work was carried out prior to prototyping</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>There was no involvement from manufacturing at the development stage</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The product design specification or outline of requirements was regularly reviewed as the design developed</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The product design specification or outline of requirements was regularly updated as the design developed</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The manufacturing process was developed in parallel with the product</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>A full test and validation plan was developed at this stage, including testing methods, responsibilities, schedules, and costs</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Decisions about production sources and production assembly techniques went on in parallel with design</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>We outsourced significant parts of the design process</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>The FMEA was thoroughly reassessed at the end of the development process</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>
To what extent are the following statements true for the project DURING DEVELOPMENT? (Please rate ALL statements below):

### Prototyping

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>We began producing prototypes early on in the development process</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The modelling or prototyping totally altered the product design specification</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Customers were highly involved in prototype appraisal</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We outsourced all the prototype building</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

### Tooling

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>We completed product and process designs prior to committing resources for implementation</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Customers wanted to see full production parts early on in the development process</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We committed to production tooling before we had fully manufactured prototypes</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

### Testing/Validation

#### Product

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>We evaluated laboratory tests to determine the performance against specifications</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We interpreted the findings from the in-house trials and incorporated them into product design and commercialisation plans</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We carried out extensive product/component bench testing to determine performance against specifications</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We carried out extensive in-vehicle testing</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Customers were highly involved with the product testing</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We outsourced significant parts of the testing programme</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

#### Process/Production Validation

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Validation of off-tool production was carried out poorly</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We ran capability studies to optimise the production process for this product</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We carried out employee training well</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Several iterations of the product development process were required before we began full scale production</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

### Market Launch

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>We completely satisfied our customers delivery schedule with respect to timing</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>We completely satisfied our customers quality requirements</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The product met all the legislative requirements</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The product which entered the market was significantly different to that approved at the initial screen</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

### SECTION 3

**The External Environment**

The corporate and market environment within which the product is developed and launched can affect the outcome of the development project. To the best of your knowledge, please rate the following environment characteristics by circling the appropriate number.

Please rate ALL statements below:

#### Company Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial resources</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>R&amp;D/product development skills</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Manufacturing / production resources</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Management skills</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Market research skills</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Engineering skills</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Distribution resources</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>
Please rate ALL statements below:

**The Market for the Product**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential customers had a great need for this class of product</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The market for this product was growing very quickly</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The market size (either existing or potential) for this product was large</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Competing products were very similar to each other</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Non-price competition in the market was very intense</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Potential customers for this product were very loyal to competitors’ products</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>There were many competitors in this market</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>There was a strong, dominant competitor in this market</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Potential customers for this product were very satisfied with competitors’ products</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>There were barriers to entry for new competition</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The market was characterised by intense price competition</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

**SECTION 4 Performance Measures**

This section looks at the performance or commercial outcome of the new product chosen, to be gauged a number of different criteria. Please indicate, from what you know today, how this selected product performed using ALL the following criteria. Please circle the appropriate number.

Please rate ALL statements below:

<table>
<thead>
<tr>
<th>Performance Measures</th>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The project exceeded company's profit levels</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project exceeded margin goals</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project exceeded break-even time</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project exceeded Internal Rate of Return or Return on Investment goals</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project exceeded revenue goals</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project exceeded market share goals</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project exceeded sales volume goals (units not revenue)</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project exceeded the targets of customer acceptance</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project exceeded the targets of customer satisfaction</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project met acceptable reject levels</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The project met acceptable warranty levels</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The product exceeded the performance specifications</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The new product was considered to be a technological success</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The product opened up a “window on other opportunities” in terms of a new product category for your company</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The product opened up a “window on other opportunities” in terms of a new market opportunity for your company</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The new product was developed within the budget constraints</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The new product was ready ahead of time</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>The new product was launched on time</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

Was your product rated against any other measures of performance? Yes □ No □

If Yes, please specify and rate:

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>
### SECTION 5

**Background Information**

<table>
<thead>
<tr>
<th>approximately how many employees does your company have? (full time equivalent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>95/96</td>
</tr>
</tbody>
</table>

| Approximately what was the Turnover for your company for these years? |
| 95/96 | 96/97 |

| approximately what percentage of the turnover was spent on R&D/Development? |
| 95/96 | 96/97 |

| is your product high or low technology? (please circle the appropriate number) |
| Low Technology | Medium Technology | High Technology |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

| Are the majority of your products aimed at mass markets or more specialised niche markets? (please tick one box) |
| Mass markets | A combination of mass and niche markets | Niche markets |

| which one of the following categories best describes your company? (please tick one box) |
| Market Driven | Driven by a combination of market and technology | Technology Driven |

| which one of the following categories best describes your job function: (please tick one box) |
| R&D/Development | Design | Marketing | Manufacturing | Other: please specify |

| job title: |

| which of the following best describes your management level? |
| Director | Senior Manager | Functional Manager | Product Manager | No management responsibility |

If you would like to receive a copy of the summary findings of this research please fill in your name and address below:

The findings of this research are absolutely confidential. Only summary findings will be available, individual respondents and companies will not be identified.

**Thank you for your help**
APPENDIX 7.1

RESIDUAL PLOTS FOR FACTOR SCORE REGRESSION EQUATIONS
FACTOR SCORE RESIDUALS

FINANCIAL

Histogram of Residuals

Normal P-P Plot of Residuals

Scatterplot of Residuals against Predicted
CUSTOMER

Histogram of Residuals

Normal P-P Plot of Residuals

Scatterplot of Residuals against Predicted
PRODUCT-BASED SUCCESS

Histogram of Residuals

Normal P-P Plot of Residuals

Scatterplot of Residuals against Predicted
WINDOW OF OPPORTUNITY

Histogram of Residuals

Normal P-P Plot of Residuals

Scatterplot of Residuals against Predicted
APPENDIX 7.2

RESIDUAL PLOTS FOR VARIABLE SELECTION
REGRESSION EQUATIONS
VARIABLE SELECTION RESIDUALS

FINANCIAL

Histogram of Residuals

Normal P-P Plot of Residuals

Scatterplot of Residuals against Predicted
CUSTOMER

Histogram of Residuals

Normal P-P Plot of Residuals

Scatterplot of Residuals against Predicted
PRODUCT

Histogram of Residuals

Normal P-P Plot of Residuals

Scatterplot of Residuals against Predicted
WINDOW OF OPPORTUNITY

Histogram of Residuals

Normal P-P Plot of Residuals

Scatterplot of Residuals against Predicted