III Table of Contents

I Abstract III

II Preface IV

III Table of Contents VII

IV List of Figures XII

V List of Tables XIV

VII Acknowledgement XVII

VIII Author's Declaration XVIII

IX Definitions XIX

X Abbreviations XXI

1 Introduction 1

1.1 Research Overview 3

1.2 Theoretical Background 6

1.3 Practical Background 9

1.3.1 The Manufacturing Industry 10

1.3.2 The Consumer Market 10

1.3.3 The Retail Market 13

1.3.4 Delivery and Transportation 16

1.3.5 Operational Utilisation Structures of DPS in UMTO 19

1.4 Importance and Attractiveness 22

2 Research Question 23

2.1 Definition of the Research Question 23

2.2 Definition of UMTO Delivery with Time Windows 25

2.3 Narrowing the Focus of the Research Problem 27

2.4 Generalisability of the Research Question 30

2.5 Importance of the Cost Problem in Distribution for UMTO 32

2.6 Reflections on the Formulated Cost Problem 35
2.7 Cost of Delivery for UMTO 36
2.7.1 Identifying Cost Parameters 36
2.7.2 Delivery Cost as a Share in Total Cost 38
2.8 Summary and Conclusions 41
3 Literature Review 43
3.1 Distribution Planning Approaches 43
3.1.1 Historical Development 44
3.1.2 Tactical and Strategic Planning 51
3.1.3 Heuristic and meta-heuristic Models 54
3.1.4 Stochastic & Dynamic Simulation based Planning in DPS 58
3.1.5 Planning under Certainty and Uncertainty 61
3.1.6 Tabu Search and Genetic Search 62
3.1.7 Simulated Annealing 64
3.1.8 Capacitated Vehicle Routing 65
3.2 TWC in Distribution Planning 67
3.2.1 Classification of TWC in VRP 69
3.2.2 Use of complex DPS for VRPTW 75
3.3 Distribution Planning for UMTO 78
3.3.1 SCM in Production and Distribution 84
3.3.2 Approaches for UMTO 90
3.3.3 UMTO Distribution Planning under TWC 94
3.4 Simulation Techniques in Logistics 97
3.4.1 Appraisal of existing Simulation Models 104
3.4.2 Application of Simulation in Decision Support Models 109
3.4.3 Sensitivity Considerations 112
3.5 Experimental Research 114

3.5.1 Experimental Research in Logistics 114
3.5.2 Risks in Experimental Design 115
3.5.3 Sampling and Pilot Studies in Experimental Research 116
3.6 Coherence between Simulation and Experimental Research 119
3.7 Summary and Conclusion 122
4 Methodology 125
4.1 Research Framework 125
4.1.1 Mapping the Research Design 126
4.1.2 Experimental Research Design 127
4.1.3 Simulation in the Environment of Positivistic Research 131
4.1.4 Combining Qualitative and Quantitative Research 133
4.1.5 Combining Inductive and deductive Methodologies 136
4.1.6 Parameters of Validity Substantiation 137
4.1.7 Practical and Phenomenological Research Initiations 139
4.2 Definition of the Cost Function 144
4.2.1 Influences on Delivery Cost 144
4.2.2 Supporting Cost Parameters 149
4.2.3 Cost Function and Objective Function 153
4.3 Choice of the Simulation Model 157
4.3.1 Structural and Methodological Approach 158
4.3.2 Logistics Optimisation through Simulation 160
4.3.3 Summary of the applied Simulation Model 161
4.4 Sampling and Data Input Configurations 163
4.4.1 Data Sampling 164
4.5 Analysis 168
4.5.1 Application of Descriptive Statistics 169
4.5.2 Other Multivariate Analyses 170

4.6 Critical Reflections on the chosen Methodological Approach 172

5 Research Process 175

5.1 Definition of the Research Process and DPS Selection 176

5.1.1 Research Process Definition 176

5.1.2 System Requirements 179

5.1.3 System Selection Process 179

5.1.4 System Use and Operational Specifications 181

5.1.5 Explanatory Example of the Data Simulation Process 182

5.1.6 Critical Reflections on the Chosen Approach 190

5.2 Data Collection and Processing 191

5.2.1 Data Cleansing and Selection Parameters 198

5.2.2 Validity and Reliability of the Screening 199

5.2.3 Research Process Validation 202

5.2.4 Data Request, Origin and Delivery 207

5.2.5 Data Input Format 209

5.2.6 Data Purification 214

5.2.7 Data Collection Strategy 216

6 Analysis of Results 221

6.1 Descriptive Base Data Analysis 221

6.1.1 Results – Base Data-1 222

6.1.2 Results –Base Data-2 224

6.1.3 Results - Base Data-3 226

6.1.4 Summary and Conclusions 228

6.2 Customer Service Perspective 229

6.3 Sensitivity Analysis 233

6.4 Summary and Conclusions of the Data Analysis 236

7 Supporting Environmental Considerations 239

7.1 Externalities of Road Transport 239

7.2 Pre-Requisites for Environmental Considerations..... 241

7.3 Implications of Environmental Considerations 253

7.4 Considerations on other Freight Transport Externalities 256

7.5 Conclusions and Summary 260

8 Conclusions 263

8.1 Contribution to theoretical Knowledge 265

8.2 Contribution to Literature 268

8.3 Transferability and Generalisability 270

8.4 Implications on Operational Practice..... 274

8.4.1 Significance of the Cost Advantage 275

8.4.2 Reflections on the Customer Service Dimension 279

8.4.3 Implementation Scenarios 280

8.4.4 Summary of Implications..... 282

8.5 Further Research Opportunities..... 283

XI Appendix 287

XI.A Trends and Strategies in Logistics and SCM..... 288

XI.A.i Customer Focus 294

XI.A.ii Logistics Information Systems for the VRP 297

XI.A.iii Competitive Advantage by Cost Leadership..... 299

XI.B Supplements to the Practical Background 301

XI.B.i The Furniture Industry in Germany and Europe 301

XI.B.ii Production Planning for UMTO 311

XII References 315