Contents

1 Introduction **1**
- 1.1 Motivation and problem statement . . . 2
- 1.2 Target definition and research methodology . . . 4
- 1.3 Dissertation structure . . . 6

2 Electronic Marketplaces in the Logistics Industry **9**
- 2.1 Electronic marketplaces . . . 9
- 2.2 Electronic logistical marketplaces . . . 11
- 2.3 Benefits of ELMs . . . 19
- 2.4 Challenges in ELMs . . . 23
- 2.5 Transaction cost theory and ELM . . . 32
- 2.6 Summary . . . 36

3 Distributed Data Architectures **39**
- 3.1 Logistics and blockchains in research . . . 40
- 3.2 Basic principles of DLT . . . 41
- 3.3 Key properties of blockchains . . . 43
- 3.4 Types of blockchains . . . 48
- 3.5 Blockchain security . . . 58
- 3.6 Smart contracts . . . 60
- 3.7 Key issues of DLT . . . 66
- 3.8 Leveraging blockchain properties to overcome ELM constraints . . . 73
- 3.9 ELM in DLT - Direction for the design . . . 81
- 3.10 Research state on problem resolution . . . 85
- 3.11 International Data Space and Gaia-X . . . 87
- 3.12 Summary . . . 89

4 Requirements Analysis **91**
- 4.1 Requirements gathering phase . . . 91
- 4.2 Analysis of interviews . . . 94
- 4.3 Connection of interview results with the literature findings . . . 95
- 4.4 Business model generation . . . 97
- 4.5 Identification of possible solutions . . . 98
- 4.6 Summary . . . 99

5 Model of an ELM **101**
- 5.1 Description of the meta-model . . . 102
- 5.2 Possible extensions of the model . . . 114
- 5.3 Variability of the model . . . 123
- 5.4 Reference architecture . . . 125
- 5.5 Influence of the model on the inhibitors and enablers of ELMs . . . 130
- 5.6 Security evaluation . . . 135

5.7 Discussion . . . 165
5.8 Summary . . . 168

6 Instantiation **169**
6.1 Definition of the ELM . . . 169
6.2 Implementation with traditional technology . . . 172
6.3 BlockELM - The open ELM . . . 182
6.4 BlockELM on a consortium blockchain . . . 201
6.5 Discussion of chapter results . . . 211
6.6 Summary . . . 212

7 Design Principles for ELMs **215**
7.1 The principles . . . 216
7.2 Summary and discussion . . . 221

8 Conclusion and Discussion **225**
8.1 What has been created . . . 225
8.2 Theoretical contributions . . . 226
8.3 Practical contributions . . . 227
8.4 Limitations . . . 228
8.5 Outlook . . . 229
8.6 Conclusion . . . 230

Bibliography **231**