

TABLE OF CONTENTS

Acknowledgements 9

Chapter 1. Introduction 11

Chapter 2. Maritime transport and logistic services 17

- 2.1. Maritime transport 17
- 2.2. Trends and challenges in the maritime domain 19
- 2.3. Maritime logistic services 23
 - 2.3.1. Quality of a maritime logistic service 24
 - 2.3.2. Reliability of a maritime logistic service 27
- 2.4. Actors in the maritime supply chains 29
- 2.5. Maritime transport monitoring 31

Chapter 3. Maritime risk assessment 37

- 3.1. Maritime risk and reliability 37
 - 3.1.1. Risk management 38
 - 3.1.2. Transport risk 40
 - 3.1.3. Maritime risk 41
- 3.2. Maritime risk assessment systems and methods 44
 - 3.2.1. Formal Safety Assessment 44
 - 3.2.2. Maritime risk assessment approaches 44
 - 3.2.3. Other methods used in the maritime domain 49
- 3.3. Maritime risk variables 55
- 3.4. Shortcomings and gaps in the existing risk assessment methods 56

Chapter 4. Maritime data 65

- 4.1. Data sources used in the maritime domain 65
 - 4.1.1. Sensor data 66
 - 4.1.2. Weather data 74
 - 4.1.3. Internet sources 75
- 4.2. Maritime data quality 79
- 4.3. Data enhancement 90
 - 4.3.1. Source selection method 91
 - 4.3.2. Identification 91
 - 4.3.3. Quality measures 92
 - 4.3.4. Assessment and selection 93
- 4.4. Data extraction 94

4.4.1. Data fusion and disambiguation	96
4.4.2. Data processing and analysis	99
4.5. Maritime data sources—a summary	100
4.6. System for maritime monitoring—a case study	102
4.6.1. Outline of the system	102
4.6.2. Maritime data selection	107
4.6.3. Data retrieval and disambiguation	115
Chapter 5. Maritime routing and traffic networks	125
5.1. Ships routes prediction	125
5.2. Maritime traffic networks	129
5.3. HANSA system—a case study	132
5.3.1. Outline of the system	132
5.3.2. Method for waypoints generation	133
5.3.3. Method for traffic patterns and RC extraction	139
5.3.4. System architecture	141
Chapter 6. Maritime anomalies detection	145
6.1. Maritime threats and anomalies	145
6.2. Typology of maritime anomalies	146
6.3. Anomalies detection: Approaches, methods	154
6.4. Loitering-related anomalies detection	158
6.4.1. Speed anomaly	159
Chapter 7. Short-term maritime reliability and risk assessment	169
7.1. Outline of the method	169
7.2. Risk classifiers and variables	171
7.2.1. Ship-related classifier	175
7.2.2. Voyage-related classifier	180
7.2.3. History-related classifier	183
7.3. Application of the MMRAM method—an example	189
7.3.1. Data sources and infrastructure	189
7.3.2. Analysis results	190
7.3.3. Ranking of ships	195
7.3.4. Summary of the results	197
Chapter 8. Ship's punctuality prediction	199
8.1. Outline of the method	199
8.2. Route prediction	202
8.3. Travel time profile	206
8.4. Additional variables	208
8.4.1. Congestion	208

8.4.2. Hazard index	211
8.4.3. Weather and sea state	216
8.4.4. Past delays	217
8.5. Determination of ship's punctuality	218
8.5.1. Travel time updates	218
8.5.2. ETA prediction	220
8.6. Application of the SPP method—an example	221
8.6.1. Data sources and infrastructure	223
8.6.2. Analysis results	223
8.6.3. Congestion results	228
8.6.4. Hazard results	232
8.6.5. Delay factor results	237
8.7. Summary of the results	239
Chapter 9. Application of big data technologies for maritime data analysis	243
9.1. Application of big data technologies for maritime anomalies detection	243
9.1.1. Methodology	245
9.1.2. Anomaly detection	247
9.1.3. Traffic analysis	247
9.1.4. Static anomalies	248
9.1.5. Loitering detection	255
9.1.6. Benchmark	257
9.2. Maritime traffic network analysis	261
9.2.1. Methodology	262
9.2.2. CUSUM	263
9.2.3. Spatial partitioning	267
9.2.4. Genetic algorithm	269
9.2.5. AIS enrichment	273
9.2.6. Reconstruction of edges	281
9.2.7. Maritime traffic network evaluation	290
Chapter 10. Summary	305
Appendix A. Evaluation of the MRRAM method—results	309
A1. Statistics of accidents for ship types and classification societies	309
A2. Bayesian Network parameters for the risk classifiers	312
Appendix B. Evaluation of the SPP method—results	318
B1. Results of route prediction method	318
B2. Hazard index—results	332
References	333
List of tables	350
List of figures	352