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FRAUNHOFER CENTER FOR MARITIME LOGISTICS AND SERVICES CML

# TERMINAL OPERATING SYSTEMS 2021

AN INTERNATIONAL MARKET REVIEW OF CURRENT  
SOFTWARE APPLICATIONS FOR TERMINAL OPERATORS



FRAUNHOFER VERLAG

FRAUNHOFER CENTER FOR MARITIME LOGISTICS AND SERVICES CML

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Hamburg, December 2020

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## **Fraunhofer Center for Maritime Logistics and Services CML, Hamburg**

The Fraunhofer Center for Maritime Logistics and Services CML develops and optimises processes and systems along the maritime supply chain. We support private and public-sector clients with the initiation and realisation of innovations through practical research projects in the fields of shipping, ports, and logistics.

In accordance with the project and customer requirements, we put together interdisciplinary teams of engineers, economists, mathematicians, information scientists and marine engineers to create customer-specific solutions for ship and fleet management, marine transport and navigation, ports and transportation markets.

We take both the results of our varied research activities and the latest scientific insights into account. Fraunhofer CML is part of the Fraunhofer Institute for Material Flow and Logistics IM L in Dortmund.

### **Ports and Transport Markets**

Ongoing globalization, the availability of innovative technologies and rapidly changing market requirements are altering maritime supply chains. Making infrastructures and transport chains more flexible is one answer to these developments. CML supports its customers with market development trend studies and assists with strategic, future-oriented investment decisions.

### **Sea Traffic and Nautical Solutions**

The growth of maritime transportation and increasing ship sizes poses safety and efficiency challenges in maritime shipping that can be overcome through information technology innovations and nautical solutions. CML brings these two sides together in maritime transport and navigation. Ship technologies, traffic, and waterways are analysed, assessed, and optimised, thereby improving the efficiency and safety of shipping traffic.

### **Ship and Information Management**

Modern maritime information management on board and on land harbours significant efficiency and cost effectiveness potential. One focus is on crewing and procurement processes that often constitute a large proportion of the operating costs. CML develops and pilots' individual solutions for its customers to optimise business processes for the operation and control of shipping fleets.

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Dear reader,

Port Terminals today, are highly complex ecosystems where many areas of operation intersect. Activities ranging from cargo handling and yard management to veterinary services and customs need to be planned, coordinated and executed at a minute's notice.

Terminal Operating Systems (TOS) fill this role. They act as inherently complex systems that manage and monitor all aspects of a terminal's operative tasks. However, as no port is like another, TOS come in equally different designs, each with a specific terminal in mind, and are then highly customized towards the needs of the customer. This implementation is costly and time consuming, which makes it crucial to make an informed choice when selecting a new TOS for introduction.

There are a number of innovations that, over the span of the last ten years, have made TOS all over the world more productive, leaner and more self-sufficient. Especially the emergence of the means for omnipresent data collection laid the groundworks for one of the pinnacles of recent technology - Artificial Intelligence. This development is by all means ongoing, however, more and more providers and users of TOS start to tap into this enormous potential as Artificial Intelligence opens up opportunities for better coordinated and more efficient operations, lower energy consumption and seamless communication.

This is why this year's study on TOS focuses on the implications of Artificial Intelligence on the way terminals are managed now, and will be managed in the near future.

It will inform you about what is on the market and what the capabilities of these systems are, and hopefully help you in the quest of becoming the terminal of the future by using what is available today.

Enjoy your read!

Carlos Jahn



*Prof. Dr.-Ing. Carlos Jahn  
Head of Fraunhofer Center for Maritime Logistics and Services CML*

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## LIST OF ABBREVIATIONS

|       |   |
|-------|---|
| AGV   | AUTOMATED-GUIDED-VEHICLE  |
| AI    | ARTIFICIAL INTELLIGENCE   |
| AIS   | AUTOMATIC IDENTIFICATION SYSTEM, GERMAN: AUTOMATISCHES IDENTIFIZIERUNGSSYSTEM |
| ASEAN | ASSOCIATION OF SOUTHEAST ASIAN NATIONS  |
| ASW   | ASEAN SINGLE WINDOW   |
| ATLAS | AUTOMATISIERTES TARIF- UND LOKALES ZOLL-ABWICKLUNGS-SYSTEM                    |
| BI    | BUSINESS INTELLIGENCE   |
| CCTV  | CLOSED CIRCUIT TELEVISION   |
| CSV   | COMMA-SEPARATED VALUES  |
| DB    | DATABASE  |
| EDI   | ELECTRONIC DATA INTERCHANGE   |
| ERP   | ENTERPRISE RESOURCE PLANNING  |
| GCP   | GROSS CRANE PRODUCTIVITY  |
| GUI   | GRAPHICAL USER INTERFACE  |
| HR    | HUMAN RESOURCES   |

|       |  |
|-------|--|
| ICT   | INFORMATION AND COMMUNICATION TECHNOLOGIES     |
| IoT   | INTERNET OF THINGS                             |
| ISO   | INTERNATIONAL ORGANIZATION FOR STANDARDIZATION |
| IT    | INFORMATION TECHNOLOGY                         |
| KPI   | KEY PERFORMANCE INDICATOR                      |
| MS    | MICROSOFT                                      |
| MSW   | MARITIME SINGLE WINDOWS                        |
| NSW   | NATIONAL SINGLE WINDOWS                        |
| OCR   | OPTICAL CHARACTER RECOGNITION                  |
| PCS   | PORT COMMUNITY SYSTEMS                         |
| PDF   | PORTABLE DOCUMENT FORMAT                       |
| RDT   | REAL-TIME-DATA                                 |
| RFID  | RADIO FREQUENCY IDENTIFICATION                 |
| RIS   | RIVER INFORMATION SERVICES                     |
| RoPax | ROLL-ON/ROLL-OFF & PASSENGERS                  |
| Ro/Ro | ROLL-ON/ROLL-OFF                               |
| STS   | SHIP-TO-SHORE                                  |
| TAS   | TRUCK-APPOINTMENT-SYSTEM                       |
| TEU   | TWENTY-FOOT EQUIVALENT UNIT                    |
| TOS   | TERMINAL OPERATING SYSTEM                      |
| VHS   | VERY HIGH FREQUENCY                            |
| VTS   | VESSEL TRAFFIC SERVICE                         |
| WLAN  | WIRELESS LOCAL AREA NETWORK                    |
| XML   | EXTENSIBLE MARKUP LANGUAGE                     |

# 1 MANAGEMENT SUMMARY

Technological progress and changing business environments of port terminals can force port terminals to consider updating or changing their present Terminal Operating System (TOS). Up-to-date TOS offer the potential for higher productivity and efficiency in the operation of port terminals. To realize these potentials, port terminals need to select a suitable TOS system from the right TOS provider. Just buying a product off the shelf often won't work, it rather requires substantial financial and personnel commitment towards a TOS provider. Procurement and implementation may last years. Thus, a prudent decision needs to be made on which provider and which TOS product to choose..

The TOS 2021 study provides support in the first steps of a TOS user's procurement process, giving an overview of 38 TOS providers at market, their products and modules. For TOS providers the study gives valuable insights in the demand of TOS users and their needs. Both parties profit of an extra spotlight of the 2021 study on the benefits and prevalence of Artificial Intelligence in TOS products.

A strong diversification and specialisation of TOS products can be observed over the last years. Port terminals handling containers face a more and more consolidated market, in which the number of TOS products declined by 21%. Also, the number of available TOS products for Ro/Ro port terminals falls by 24%. Contrarily, there has been an influx of new products marketed towards port terminals handling dry and liquid cargo as their numbers increased significantly. The market for TOS specialised on general cargo port terminals remains unchanged.

Methods of Artificial Intelligence within TOS offer several innovation pathways for both TOS users and providers.

- Artificial Intelligence will support decision making and thus help to make better decisions based on the available data and knowledge gathered by deep learning

and neuronal networks. This enables better forecasts based on Artificial Intelligence.

- Optimization problems are omnipresent in port terminals, for instance Stowage Planning, Yard Planning or any scheduling tasks. AI-based algorithms promise to generate solutions to these problems faster and often more effectively than traditional solutions.
- Maintenance and repair modules in TOS products will profit from Artificial Intelligence. Predictive maintenance will help to reduce equipment failures and thus increase the reliability of plans and schedules. Wear and Tear can be assessed more accurately and incorporated into the maintenance strategy. Especially, if port terminals strengthen their collaboration with port equipment providers and their data centres.

Benefits of AI become additional features within current TOS products. Port terminals pursuing the course of a first mover strategy should conduct R&D jointly with their TOS provider, tackling the systems requirements for Artificial Intelligence applications. This will open many promising pathways as well for the TOS provider, to shape future TOS product developments and maintain the company's success.

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