SMART PORT LOGISTICS

OPPORTUNITIES AND CHALLENGES FOR TRANSITIONING TO SMARTER PORT OPERATIONS

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The march of digitalization is continuing to change logistics processes around the world. After many successful decades of digitalization and automation in contemporary ports, the next big step is to look at innovative ways for extracting more value from new and existing data sources to achieve competitive advantages. Related business objectives may involve an improvement of the visibility and operational efficiency, utilization of resources, coordination among actors, security and safety, and resilience against disruptions. The trend is particularly driven by powerful information technology and paradigms already available and widely discussed in the port industry, including the internet of things, cloud computing, big data, blockchain, augmented reality — you name it. Under the umbrella of digital ports or smart ports, new innovative business models, concepts, and ideas have begun to be implemented or seem to be within reach.

Generally, those enabling technologies facilitate the gathering of more granular data from port operations and advance information dispersion and information exchange. However, an even greater potential is expected through improved intelligence that better utilizes available data sources through predictive analytics and prescriptive analytics, which includes methods to obtain actionable insights, e.g., by forecasting what is likely to happen in the future, and to optimize the course of action, respectively. In this context, the use of real-time contextual data, reflecting the current situation in port procedures and environments, has a lot of potential for enhancing planning, controlling, and management of resources. However, digital transformation is not only about technology. Technology is just a means, not an end. Therefore, it is important to not only understand the potential of enabling technologies, but, more importantly, to make purposeful and effective use of them by adapting and transforming port procedures taking into account strategic objectives.

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In the new era of digitalization, we can observe an inflationary use of the label ‘smart’: smart objects, smart home, smart city, smart governance, smart logistics, and nowadays even smart ports. The broader the context, the more concepts are involved supporting technical, economic, ecological, and social innovation. In the narrow sense, smart is a synonym of “clever” or “intelligent”, which can be seen as an ability to acquire, understand, and apply relevant information to make informed decisions and extract knowledge that may lead to some benefit. A smart object, for example, is any object or product that is, by means of embedded technologies, aware of its environment and state, may have the ability to make its own decisions about itself and its uses, communicate state information, and achieve actuation under its own control. Embedded technologies

(e.g., sensors, sensor networks, actuators, RFID) can already be found in many areas of contemporary ports and allow a high degree of automation. Another example are intelligent containers that are equipped with identification and sensing technologies, e.g., by integrating hybrid RFID-WSN (radio-frequency identification, wireless sensor network) devices and mobile technologies in order to constantly measure their environment and state (position, temperature, humidity, security seal, etc.), communicate measurements to an information system, and process and analyze data to gain insights and support decision-making. While data acquisition nowadays mostly driven by the paradigm of the internet of things, connecting physical objects to information systems or allowing machine-to-machine communication, other paradigms such as cloud computing and big data technologies play an important role in integrating, storing, processing, and analyzing massive amounts of data from different sources to obtain actionable insights. Due to the high complexity, predictive and prescriptive analytics need to be developed and applied for extracting those insights as well as for supporting decision-making.

Against this background, smart port logistics aims at providing means of planning and control to better utilize port-related resources, equipment, and space by improving the communication and information exchange, security and safety, coordination, and responsiveness in port operations through an effective combination of enabling technologies and advanced methods in form of predictive and prescriptive analytics. There is strong evidence that these efforts not only result in lower costs or higher service levels, but also tend to create less emissions of greenhouse gases.

EXAMPLE: PORT-IO

The mobile cloud platform port-IO has been developed by our team at the University of Hamburg. The platform combines cloud and mobile technologies with interdisciplinary approaches to improve planning, control, and coordination in port-related drayage operations. The platform can be used to better match demand with available capacities and reduce empty moves based on real-time data, including traffic forecasts, predicted waiting times at port facilities, and current positions and capacities of vehicles within the port area. Fast and efficient optimization techniques are used to rapidly and efficiently match transport demands and resources in complex situations. The resilience against disruptions can be increased by adapting planning dependent on the current situation measured through sensors, mobile technologies, and information from other port-related information systems. The solution further supports multi-criteria decision-making to identify trade-offs between economic and environmental objectives, which is important for the sustainable development of ports.

DIGITAL TRANSFORMATION

Past developments show how digital innovation has shaped the modernization of ports and has become indispensable to the competitiveness of ports. Regarding current trends, it is important to understand the potential and implications of enabling technologies for increasing operational efficiency, solving current problems, improving customer experience, and innovating services to achieve competitive advantages. Once strategic goals and key performance indicators are set, the actual transformation involves not only changes at the technology level, but in particular changes of organizational conditions (e.g., organizational structures, business processes, culture, employee skills, etc.). It is important to regularly determine the impact and progress of digital transformations, for example, by applying means to measure the digital maturity level.

CHALLENGES

LACK OF DIGITAL STRATEGIES

"Strategy, not technology, drives digital transformation" is a common opinion of executives according to a recent research study by MIT Sloan Management Review and Deloitte. It is important to first systematically identify potentials of digital solutions in port-related processes and then derive comprehensive and consistent digital strategies. This also involves thinking about new business models, partnerships and alliances, value-added services, and a realignment of business activities based on new digital capabilities and transformed procedures. In smart ports, legacy systems and innovative digital solutions need to be integrated to adequately redesign port-related processes and business networks along the value-added chain. This further implies ways to increase the willingness to share data in competitive port environments and among ports. According to empirical findings, an increased willingness to share data in the area of transportation and logistics is observed in recent years. While inter-organizational platforms for sharing, mostly static paper documents and information are available since decades (e.g., in form of port community systems), there is an increasing need to permanently update involved actors and decision-makers about the current situation and changes in inter- and intra-port operations based on real-time information.

EXPERTISE AND LEADERSHIP

A high degree of expertise and interdisciplinary knowledge is required to develop and implement smart operations. Ports need to seek out experts having a solid foundation in modeling, mathematics, statistics, and computer science (e.g., cyber security, distributed computing). To steer digital transformation into the right

direction, these areas of expertise need to be combined with a detailed knowledge of port operations. This requires at least dedicated study and training programs. We can already see several crowd-sourcing events organized worldwide in the form of hackathons or student challenges (see, e.g., PEMA student challenge), encouraging students and scholars to develop new innovative solutions for port environments. Collaboration between universities and ports can be beneficial for establishing interdisciplinary educational programs in the area of smart ports, but also for exploiting and extending existing knowledge and methodologies. Scholars might benefit from the practical insights of practitioners. On the other hand, it is essential to help employees and leadership to develop their professional skills and expertise regarding digitalization. Leadership further needs to develop skills and management methods to drive and implement digital projects and programs by considering objectives of digital strategies.

STAKEHOLDER INVOLVEMENT AND ACCEPTANCE

The success of smart port logistics initiatives usually highly depends on inter-organizational collaboration and network effects. Governance models need to be revisited in order to find new ways of improving the collaboration and information exchange within and between ports. Stakeholders need to realize the potentials for their own business and agree to share the required information necessary to accomplish the envisioned business transformation on both sides. Pilot projects and prototypes may help in demonstrating the solutions, which can be complemented by workshops and trainings. Another important success factor is the trust in applied solutions. Technically, the question of how the port handles cyber security issues are nowadays even more important than before.

CONCLUSION

We currently are realizing the dawn of a new era of digitalization in ports alongside exciting opportunities and challenges for established and new actors. To steer their course along desired directions and sidestep potential problems, it is important to use knowledge of past experiences, invest in digital awareness and skills, and promote innovation and collaboration. Pioneering smart port projects can be already found in major ports, such as in the Port of Hamburg, indicating the huge potential of smart port logistics and operations. So, it seems that the time has come to use new and innovative solutions in forming the future of sustainable and smart ports.

REFERENCES

Dekker, R., Bloemhof, J., & Mallidis, I. (2012). Operations Research for green logistics–An overview of aspects, issues, contributions and challenges. European Journal of Operational Research, 219(3), 671-679.

Heilig, L., Lalla-Ruiz, E., & Voß, S. (2017). port-IO: an integrative mobile cloud platform for real-time inter-terminal truck routing optimization. Flexible Services and Manufacturing, DOI: 10.1007/s10696-017-9280-z.

Heilig, L., Schwarze, S., & Voß, S. (2017). An analysis of digital transformation in the history and future of modern ports. In Proceedings of the 50th Hawaii International Conference on System Sciences.

Heilig, L., & Voß, S. (2014). A cloud-based SOA for enhancing information exchange and decision support in ITT operations. In International Conference on Computational Logistics. Lecture Notes in Computer Science 8760.

Heilig, L., & Voß, S. (2016). Information systems in seaports: a categorization and overview. Information Technology and Management, DOI: 10.1007/s10799-016-0269-1.

HPA (2015). HPA goes smartPORT. Hamburg Port Authority (HPA). URL: http://www.hamburg-port-authority.de/de/presse/broschueren-und-publikationen/Documents/150422_tl_messe_lowres.pdf

Kane, G. C., Palmer, D., Phillips, A. N., Kiron, D., & Buckley, N. (2015). Strategy, not technology, drives digital transformation. MIT Sloan Management Review and Deloitte University Press. URL: http://sloanreview.mit.edu/projects/strategy-drives-digital-transformation/

López, T. S., Ranasinghe, D. C., Patkai, B., & McFarlane, D. (2011). Taxonomy, technology and applications of smart objects. Information Systems Frontiers, 13(2), 281-300.

PEMA (2017). The PEMA student challenge. URL: http://www.pema.org/pema-events/pema-student-challenge/

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ABOUT THE ORGANISATION

The Institute of Information Systems of the University of Hamburg (Germany) specializes in interdisciplinary research for supporting decision-making processes within various application areas. A strong research focus is on quantitative methods, data mining, and cloud computing for supporting the planning and management in port logistics. Numerous publications in highly-ranked journals emphasize the quality of the institute's research. Several projects in the port industry have been successfully carried out in recent years.

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