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INTRO AND RESEARCH GOALS

This study examines the potential of Digital Twins (DTs) to improve container terminal operations. DTs are defined as a digital replica of a physical environment, in our case container terminals. A DT can provide information in real time on the physical system, as well as supply simulative and scenario analyses to understand the behavior of such a system. In this study, the focus lies on container handling processes and terminal productivity.

A DT shows two main properties. Firstly, the DT is fed with real-time data, such as sensor data provided by IoT systems or automatically transmitted business data from supply chain partners. This provides a clear picture of the current situation and upcoming developments. Secondly, the DT shows a double-loop structure involving both information and actions. Indeed, the virtual system must be able to push the decisions derived from simulation back to the physical system.

It is proven that the adoption of a DT can lead to numerous advantages, e.g., an improvement in productivity and the overall performance of the system. However, detailed DTs are still not the norm. At container terminals, container handling operations have been traditionally planned and tracked in Terminal Operation Systems (TOS). They, however, do not necessarily take all relevant real-time data into consideration and they lack the ability of simulate alternatives. In many situations, only simulation and emulation properly assess the impact of decisions. But how long is the road to turn today's TOS solutions into DTs?

The goal of this research is to shed light on the ongoing IT developments at container terminals and their TOS solutions (including add-ons and integrated third-party software). Which potential do practitioners see in DTs to improve the operations of container terminals?

RESEARCH METHODOLOGY

In order to survey the potential of DTs for container terminal operations, a Delphi Study has been planned. This method aims at achieving consensus from a panel of experts in the field. The Delphi Study is composed of an iterative questionnaire process that stops once consensus is reached (in at most 3 rounds).

1. The first round is composed of a set of statements for which the experts express their level of agreement. The results of this round are analyzed and the participants are provided with a report on the opinion of the panel.
2. In the second round, the experts are shown the consensus value and they are given the chance to revise their answers from Round 1. In addition, they are asked to provide reason in case they remain with their deviating answer.
3. In case all participants reach consensus, this study concludes after Round 2. If the panel continues to disagree on answers, there may be a third round. The third round is structured like Round 2 and allows participants to revise their answers.

For each round, the participants are asked, if possible, to answer within two weeks. The participants will be always guaranteed anonymity.

In the end, the Delphi Study shows in which regards the current TOS solutions can already be understood as DTs and which abilities today's TOS solutions lack. Which practical demands exist and which aspects of terminal operations deserve more attention in the future? The participants are provided with a detailed report on the research results first-hand.