Project Title: Container Terminal Automation

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Project Objective

The objective of this study is to undertake an in-depth analysis of the drivers of container terminal automation, the realized benefits, stakeholders' attitudes towards automation, and specific implementation and investment considerations.

Problem Statement

The decision to automate usually results from a complex interplay between multiple possible drivers and perceived benefits. In some parts of the world, particularly, the United States and Europe, the introduction of automated terminals has been very controversial and there is little publicly-available data available regarding what drives the automation decision and the benefits of automation.

Research Methodology

A database of global automated terminals was developed, with 59 features grouped into the following categories: operations, environmental and energy-saving, financial and cost savings, social, safety/security and resilience factors, and marketplace position. Terminals were surveyed to determine the combination of factors that drove their decision to automate and whether anticipated benefits of automation were realized once the terminal was in operation. In addition, the survey shed light on stakeholders' attitudes towards automation, and technical, financial, and integration factors associated with automation implementation.

Results

Sixty-two container terminals were identified worldwide that are fully or partially (semi-) automated as of Q3 2021. Most of these have been developed in the past decade. Thirty-two of the 62 global automated terminals completed the survey. The findings show that most of the benefits assumed by an individual terminal operator materialized once the automated terminal was in operation. An analysis of the gaps between decision-making drivers and benefits realized revealed that *reduced labor costs*, *reduced air emissions*, *improved truck-turn times*, *elimination of human factors,* along with terminals having *limited land for expansio*n and the opportunity to *serve as a test-bed for new t*echnologies were all factors where benefits exceeded expectations. In the case of *reduced labor costs*, the differences between expectations and benefits realized is marginal (slightly negative for U.S. and Europe and slightly positive for Pacific Asia). The study also provides a regional comparison of the findings for three regions (i.e., North America, Europe, and Pacific Asia), aiming to understand better the sensitivity that might be produced due to local perspectives and culture. A further detailing of the

regional components compared the U.S. results with those of China and compared the U.S west coast and east coast terminals. In addition, the survey examined terminal operators' perspectives of various stakeholder group positions on automation along with testing and implementation issues (such as length of the testing period and the governance of system integration) and financial/managerial issues (such as the return on investment (ROI) period) for the automation investment.

	Decision-making Drivers	Benefits Realized
Increase safety	6.28	6.28
Reduce unit cost of container handling	5.94	5.63
Reduce variability in performance	5.62	5.47
Reduce labor cost	5.37	5.44
24/7 hours of operation	5.16	4.88
Eliminate human factors (illness, risk of labor disruption, etc.)	5.06	5.59
Improve efficiency to handle larger vessels	4.97	4.72
Reduce air/ GHG emissions	4.94	5.38
Improve truck turn time	4.66	5.03
Meet KPIs required by ocean carrier	3.84	
Limited land for expansion	3.63	
Increase land productivity		4.59
Test-bed for new technologies/ Showcase technological expertise of local terminal and/or research community	3.19	
Boost for technological and operational innovation by terminal operator		4.34
Competitive forces from other terminal operators who opted for automation	2.50	
Financial incentives/subsidies by public entities or port authority	1.72	
Meet KPIs required by ocean carrier		3,75

Notes: N=32 terminal operators; Scale:1=Minimum importance; 7=Maximum importance; 0=no importance.

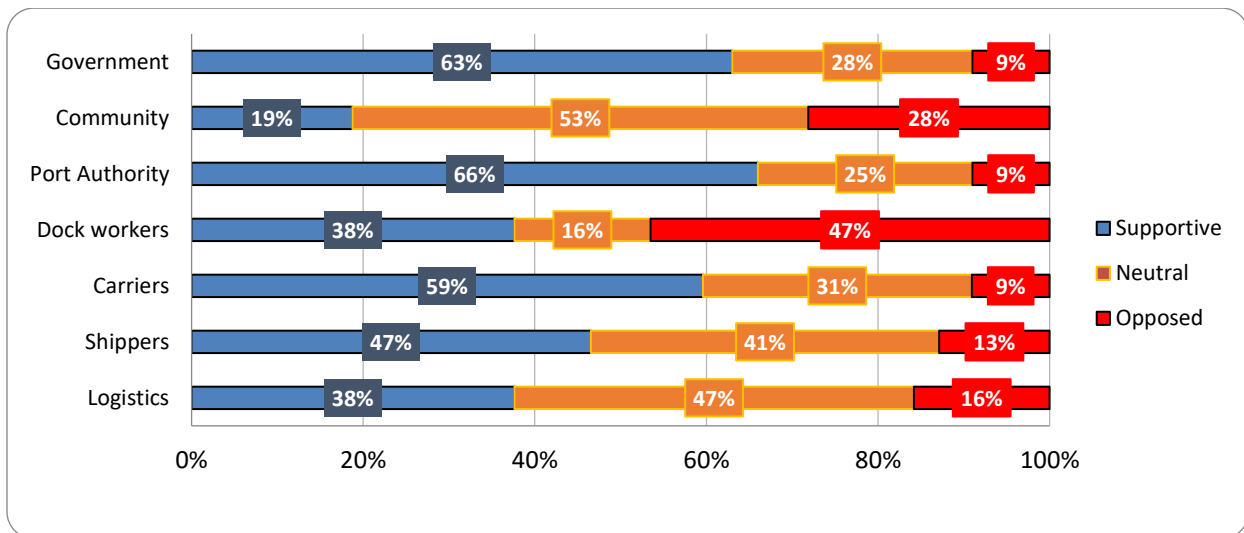**Table 1. Importance of drivers in deciding to automate container terminals and benefits realized**

Figure 1. Levels of Stakeholder Support / Opposition towards the Introduction of Automation