Presentation on

Analysis of automation in ports and terminals

- Course : INSE 6311 Sustainable Infrastructure Planning and Management Systems

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INTRODUCTION

- Automation has proved itself as a powerful tool for increasing efficiency and productivity in all areas of transportation, cargo handling, and shipbuilding.
- The potential uses of computer-controlled automation system.
  - improving the working environment
  - enhancing the quality of service
  - reducing human exposure to hazards
  - streamlining processes and systems
  - improving safety and achieving more effective and efficient use of energy.

Automation Process

The automation process is a multiphase process. The ports or terminals use a port and terminal design framework to develop an automation system.

The port and terminal design framework include the following components:

- Design
- Constraint Checking
- Installation Process
- Monitoring And Maintenance Process

Elements of Automation:

- Control Systems
- Computer Workstations
- Interface Devices
- Peripherals

Advantages

- fewer people are required to take care of processes, equipment, and workflows.
- Automatic control reduces the cost of equipment purchase and installation, and reduces personnel expenses
- Reducing the risk of accidents

Risks

- systems may fail due to a variety of reasons
- system software and hardware defects, human error, cybersecurity, or mismanagement.
- A failure or malfunction in the automation system can cause a human operator to be at risk
- An accident can occur in a port or terminal.
- the automation system cannot eliminate all the potential for accidents in ports and terminals.

Levels of Automation

Level 0: Manual Tasks

- human input is needed
- loading and unloading of ships, the hand-stowing of containers
- unloading and stacking of trucks

Level 1: Some Automation

- tasks where the machine performs only a limited part of the task.
- the robots that perform dock crane operations are often used in manual tasks such as loading and unloading of ships.

Level 2: High Automation

- handling containers by robots
- Used at warehouses and other locations in port and terminal operations

Level 3: Complex Automation (Multiple Robots and Other Forms Of Automation)

- automation where multiple robots and other forms of automation work together to carry out the task.
- Robots and automation use AI and machine learning to ensure that the task is performed safely and efficiently.

Factors to consider for automation of ports

- The Initial approach to automate a port depends on whether it is a functioning port or a newly constructing one.
- The functional approach suggests the steps to automate as below:

1. The automation of the tasks being carried out at ground level
2. the automation of information flows
3. the automation of the decision making process

Yard layout and management

As it connects the berth and the hinterland, acting as a buffer for storing containers, the storage yard plays a significant role in the overall performance of the container terminal.

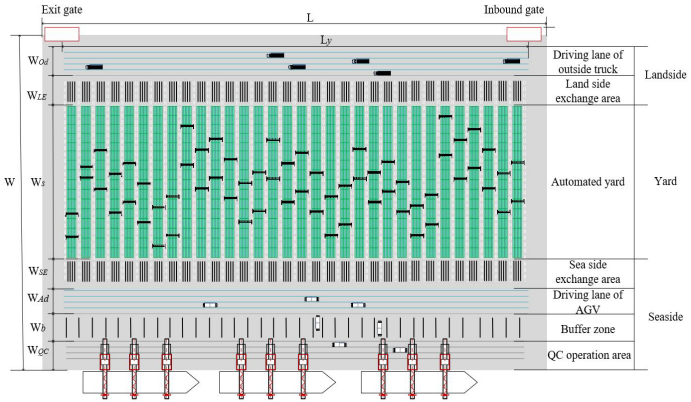
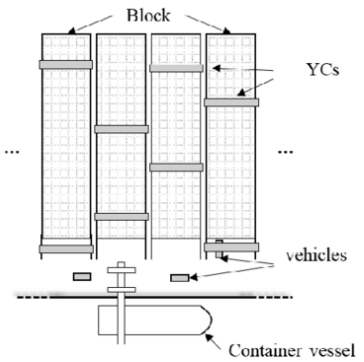


Fig – layout of automated container terminal

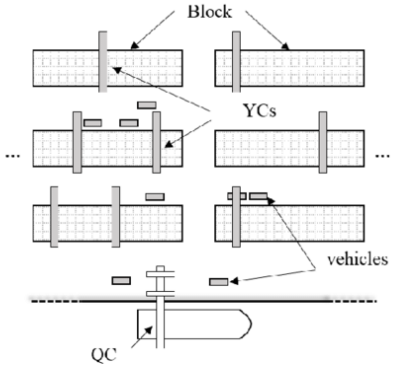
Yard layout and management

Yard management mainly involves three aspects:

- Yard layout
- Storage strategy planning
- Re-marshalling



Perpendicular Layout with End-Loading Blocks



Parallel Layout with Side-Loading Blocks

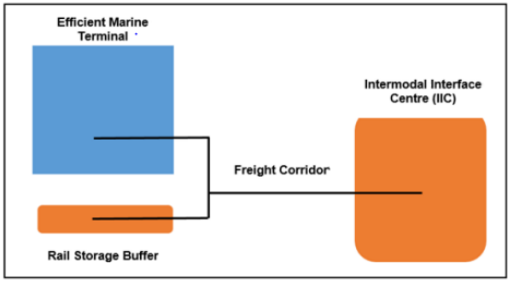
Challenges in implementation of automated ports

- The challenges in automated ports are:
- Port automation projects frequently cause major societal unrest. Port automation announcements have sparked protests and blockades from trade unions.
- Automation in container terminals may reduce human errors, but it is also likely to necessitate increased operational competencies and the unlearning of old routines, as well as the emergence of new types of human errors.
- The actual costs and social costs of automation, the social costs include social security costs (in the event of lay offs) and tax revenues foregone, when machines replace port workers.

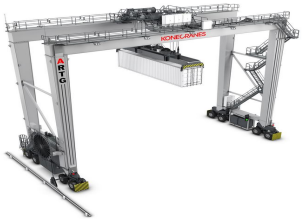
Logistics and Transportation of Freight

- Distribution of containers to the end users
- Second crucial thing in the port to achieve sustainable port infrastructure
- Rail, Road and Waterways are different ways to ship a container
- Agile port concept – Effective marine Terminal and Intermodal Interface center to effectively utilize the terminal space.

- Latest technologies like
  - Automated Gantry Vehicle and Automated Stacking Crane
  - Driverless Trains
  - Autonomous Trucks with Platooning
  - Last mile deliveries – autonomous drones



Autonomous Vehicles in logistics



Automated Gantry Vehicle

Automated Stacking Crane

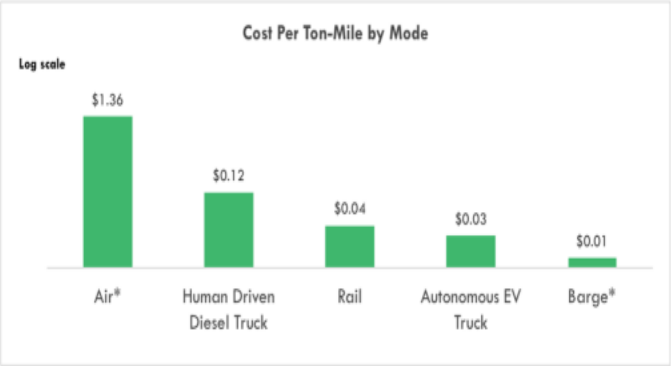
Autonomous Vehicles in port

Autonomous vehicles with platooning

Train with Double Stack Freight

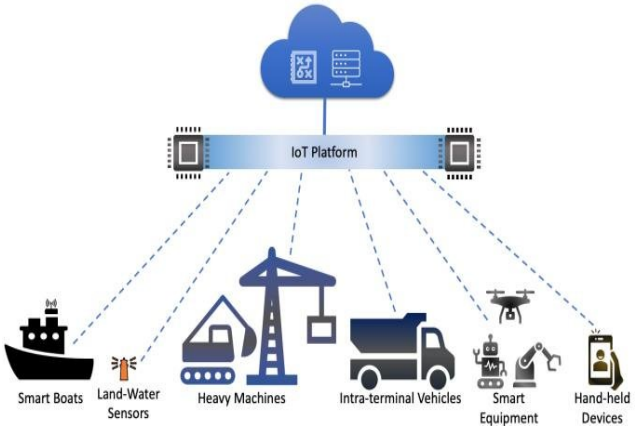
Autonomous Drones

- Digital Platforms like Big data, Cloud, RFID, GPS, Cameras and sensors are extensively used in guiding the autonomous vehicles.
- Modal shift in Freight Transport – Shifting of existing 80 percent of the container from trucks to railways or waterways to reduce environmental impact.
- Cost analysis and benefit of automation



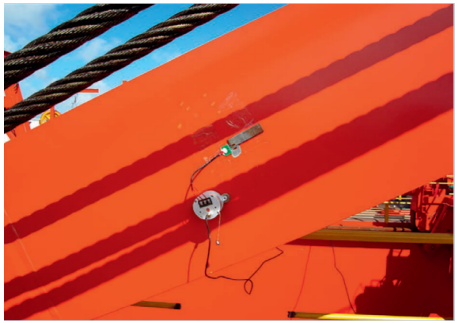
Internet of Things in Ports

- IoT solutions are the first step towards the automation of ports. They enable the devices to become smart, connect with other devices, and collect and report data about their working conditions and status.

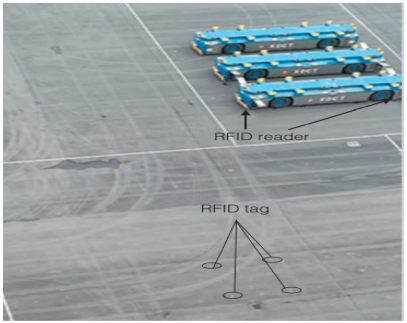


IoT and Device communication at Sea Port

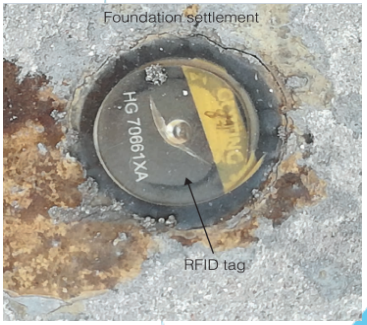
Sensing Systems for smart ports



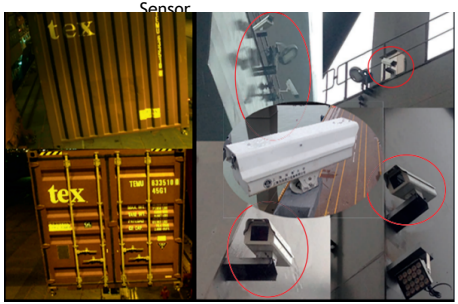
Strain Monitoring Sensor



RFID tag and RFID readers distribution

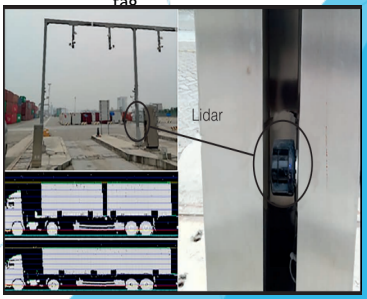


13.56 MHz RFID tag



container ID and camera system

Refrigerated Container



Container Monitor with Lidar Setup

Impact of IOT on Port Operations

- RFID is an automated identification and data collection technology and its applications in ports and terminals are:

1. Network asset visibility
2. Safety
3. Security
4. Process Automation

- Cold chain management systems use IoT-enabled sensors to monitor and regulate the environment of temperature-sensitive items preventing spoilage and waste.
- Strain monitoring sensors are used for the identification of stress and the strength reserve of the metal structure in cranes, which is an important aspect of structural health monitoring.
- LiDAR (Light Detection and Ranging technology) sensors are used for Traffic safety, Container handling and crane management in ports.
- Automatic identification of the container number, seal integrity, the lock, state of the door handle, and door orientation can be identified through computer vision techniques.

Cyber Security

Automation further increases the vulnerability and impact of cyber threats for ports.

Recent Attacks

- The Port of Houston, Aug 2021: Hackers exploit a software flaw.
- Port of Kennewick, Nov 2020: Digital Ransomware Attack.
- Port of Shahid Rajaee, May 2020: a cyberattack

KEY SCENARIOS FOR CYBER-ATTACK

Compromise of Port Community System for manipulation or theft of data

Propagation of ransomware leading to a total shutdown of port operations

Compromise of data to steal high-value cargo or facilitate unlawful trafficking

Compromise of OT systems creating a major accident in port areas

Mitigation Measures

- Ensure anti-malware and anti-virus is installed on all port systems.
- Set up backups and ensure they are regularly maintained and tested.
- Perform periodic reviews of network rules, access control privileges and asset configurations.

Cybersecurity challenges

- Lack of awareness and training regarding cybersecurity
- Lack of time and budget allocated to cybersecurity
- Lack of human resources and qualified people regarding cybersecurity matters
- Technical complexity of port information technology and operational technology systems

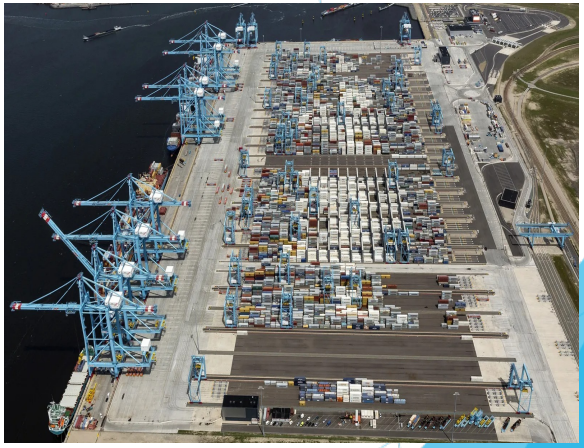
CASE STUDY - Rotterdam smart port

- Rotterdam port is now considered the most advanced in the world, with all three major parts of the container moving process automated at a built cost of over $535 million.

- Digital Twin – entire digital version of the port
  - oInsights how equipment in the port is operated
  - oReal time tracking is carried-out

- IOT sensors are used to measure the water movement,

  turbidity and measure of water pressure in regard to environmental water standards



Case Study: PORT OTAGO LIMITED
OPTIMISED OPERATIONAL CONTROL WITH THE LIVE DATA VISUALISATION

Key operational advantages:

- Visualize the live operation, follow it, and report on it.
- keep an eye on live surgeries and bottlenecks.

CONCLUSION

- With the advancement of automation in ports and terminals, the shipping industry's foreseeable future appears to be trending in the direction of fewer accidents, lower losses, increased productivity, and increased profits.
- Operating expenses could fall by 25~55 percent and productivity could rise by 10~35 percent.
- Autonomous vehicles and containers make logistics more effective.
- The port industry should collaborate with relevant government agencies to raise cybersecurity awareness and training.