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Japan-India Pilot Symposium towards Decarbonization of the Global South

Gate Operation Systems for Shorter Supply Chain in India and Expectations for Decarbonization

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- India’s Port Logistics & Challenges
- Gate Operation Automation
- Workflow mgmt. at CFS
- Container Damage Detection for Quality mgmt.

Abstract

Port logistics is crucial for India's economic growth. However, there are challenges like traffic jams at port access roads and manual checks causing around 30-minute delays per container.

We used computer vision technology to create a solution that reads container numbers, seals, and detects body damage, reducing gate passage time by 90%.

This aims to lower logistics costs and carbon emissions. Ongoing research focuses on optimizing logistics further, making India's ports more efficient and sustainable

India’s Port Logistics and challenges

Port logistics is crucial for India's economic growth (Rank 38 in World Bank’s Logistics Perf Index 2023). The challenges for the improvements.

1. Congestion on the port access

Containers will have to **wait several hours** before being checked at a gate.

2. Inefficient process and operation in CFS/ICDs

CFS: Container Freight Station
ICD: Inland Container Depot

Problem: **Long and Fluctuated Dwell Time**. It is difficult for improvement, because there is no standardization of internal process/operation.

3. Insufficient DX (digitization)

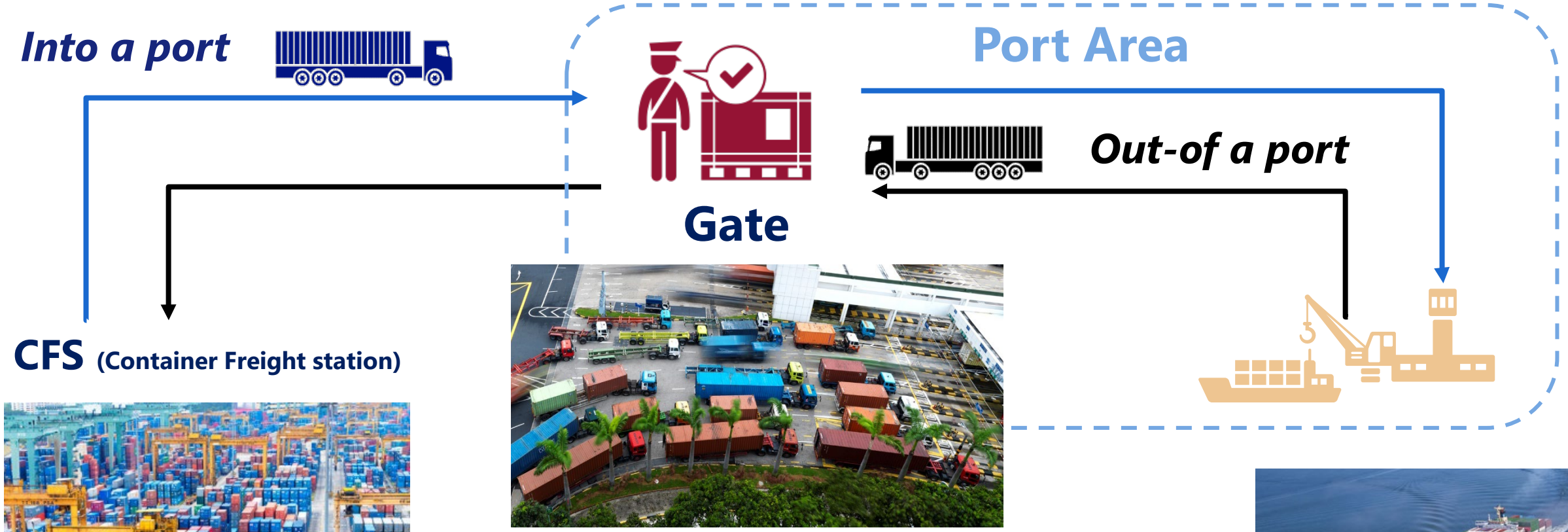
NLDS is a joint venture b/w Indian Government and NEC Corporation.

Pros: All the containers’ location are traced by NLDS (https://nlds.in/)

Cons: **The quality of current logistics is low** due to insufficient digitization and sharing of information.

References:
[1] Logistics survey in India (in Japanese), JETRO, Feb 2022.
[2] Port Logistics Issues & Challenges in India, Dun & Brandstreet Information Services India Pvt Ltd, Feb 2018

1-1 Congestion at Port Gate

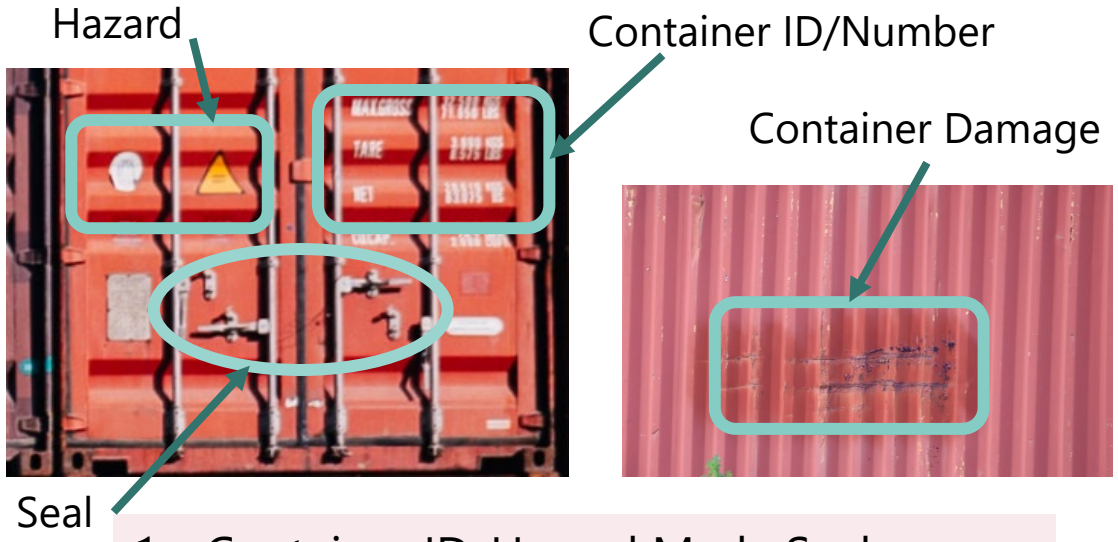


Container authentication at the gate:
- **Long queue & heavy traffic jams**
- **Manually w/ trucks stopped**

1-2 Non-Stop Gate Operation w/ Computer Visions

10x throughput by performing drive-through authentication without stopping container trucks: From 30min to 3min solutions

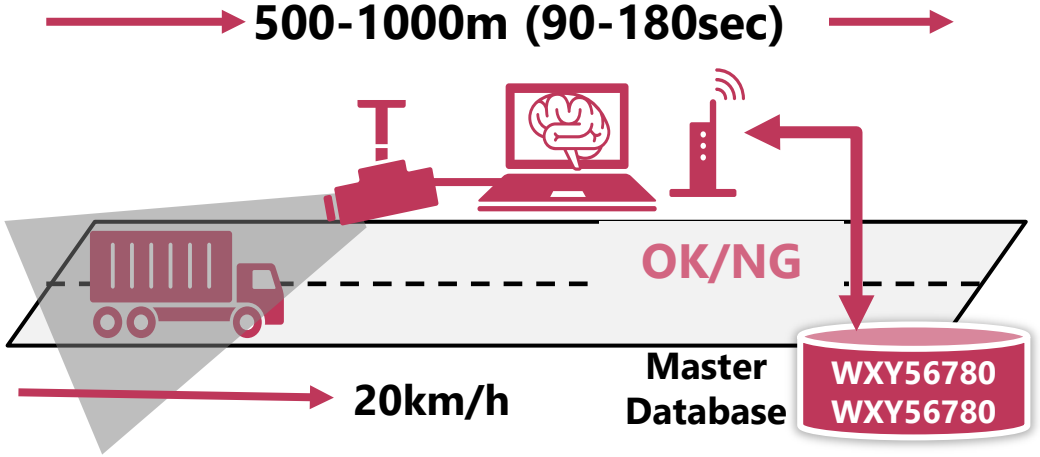
Manual Checking: 30 min



1. Container ID, Hazard Mark, Seal Checking, Damage Inspection.
2. Check against the database
3. Allow/deny entry/exit to port area

R&D Concept

Non-Stop Operation: 2-3 min



- **Automation of container authentication**
  - ✓ **10-20sec for each item matching**
- **No need for the truck to stop**
- **The system shows a driver where to go next**

1-3 Actual GoS Systems

Automatic SL at gates: From 30 min to 3 min w/ image recognition techs

Congestion at the gate entry

How much improvement?

Truck (carrying container) successfully enters the port / ICD / CFS

Container Number validation

Dent and damage detection

Vehicle number validation

Seal detection

Driver validation

Paperwork and much more….

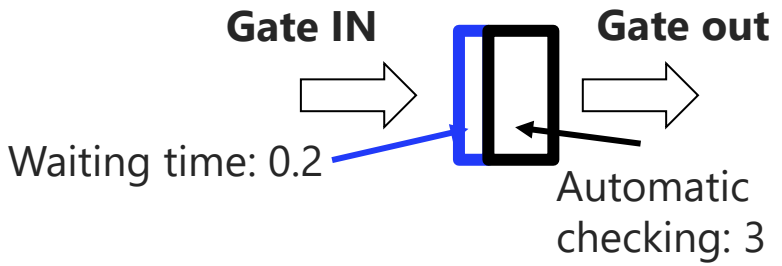
Truck (carrying container) arrives at the gate

1-4 Estimation of System Improvement using Queueing Model

- A use case analysis
  - #containers in one month: 2,000
  - Busy time: 160 containers / 16 hours = 10 containers / hour
  - Number of lanes / gates: 8
  - Arrival interval of a container for each gate: 60 min / (10 / 8) = 48 min = 1/λ
  - **Before**
    Time for manual checking: 30 min = s
  - **After**
    Time for automatic checking: 3 min = s'
- M/M/1 queueing model
  waiting time = s / (1-λs)

➢ **Manual checking at a gate**
Gate passing time = 50+30 = 80 min

➢ **Automatic checking at a gate**
Gate passing time = 0.2+3 = 3.2 min



➢ **Some implications**
 # lanes/gates could be reduced to 1
Gate passing time would be 6 min (3 + 3)

Impact to Decarbonization

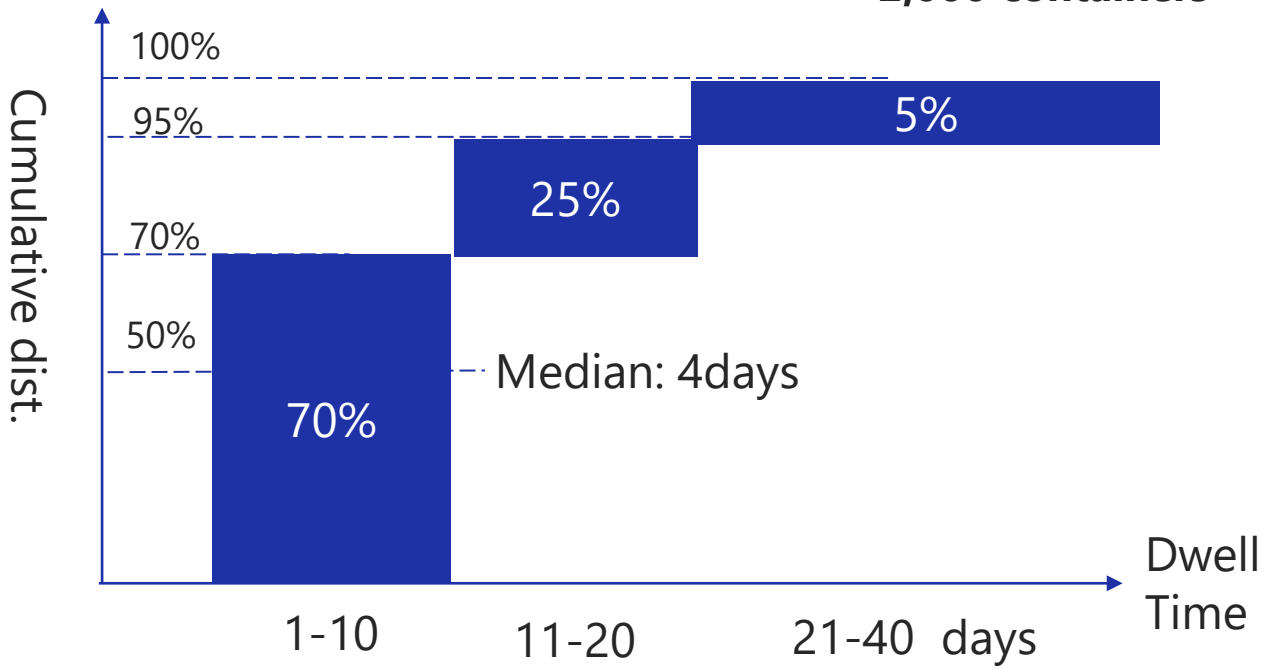
- Reduction of
  - ✓ gate passing time: 80 to 6 min
  - ✓ #lanes/gates: 8 to 1~2
- will reduce carbon emission
  - ✓ Probably by 1/10~1/20 (not verified yet)

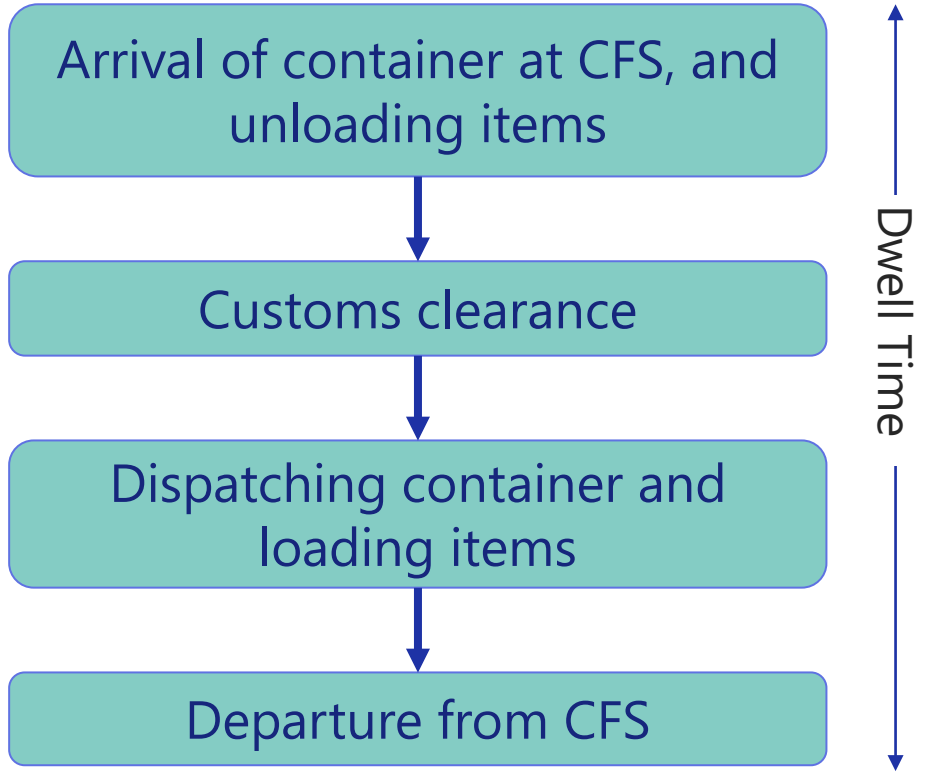
2-1. Inefficient Process/workflow at CFS/ICDs

A bottleneck of supply chain inefficiency:
long and fluctuated dwell times of containers at CFS

- Dwell time at CFS is about 7days in average, but sometimes more than 20 days.

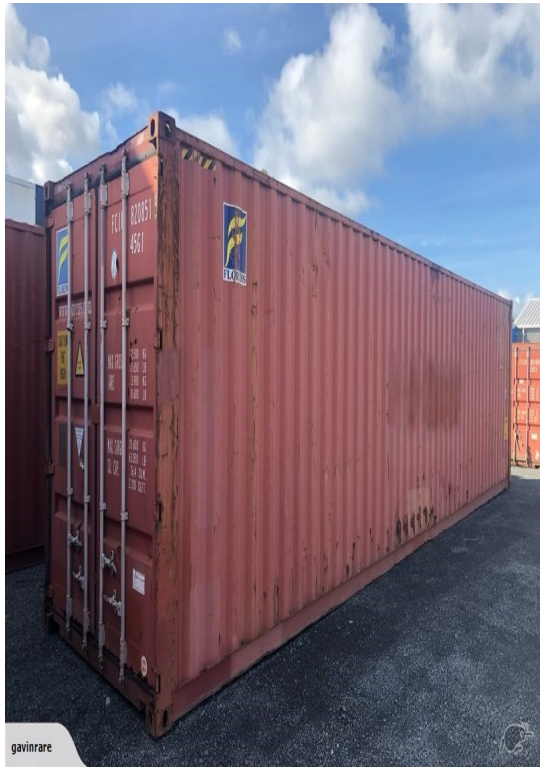
<sample of Dwell Time Dist: one CFS, one-month 2022, 2,000 containers>

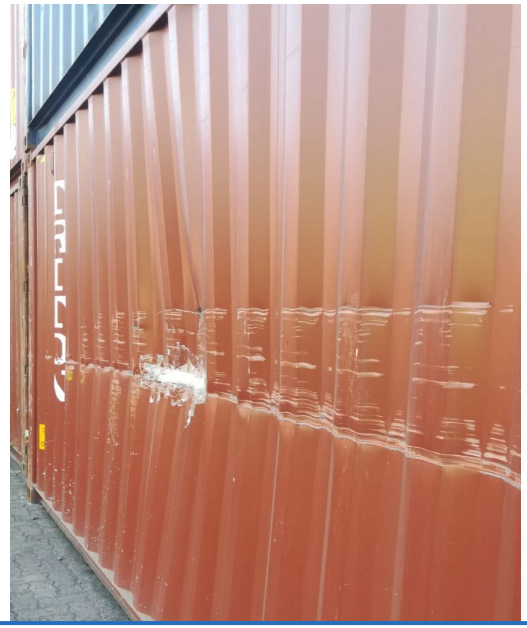




3. Container Damage Detection for Quality mgmt.

- Some containers are **still in use even with damages**.
- Items inside may be affected, resulting in loss to the item's owner.
- **Early detection** of container damage will lead to **quality improvements** in the supply chain, including container owners, insurance companies, and shippers.





Damage information is neither digitized nor shared

Summary and Concluding Remarks

1. We have developed GoS (Gate operation Systems) by applying computer vision technologies to improve congestions at a port.
   - Checking time was reduced from 30 to 3 min, and waiting time from 50 to a few min.
   - Number of lanes/gates could be also reduced, and then capacity of CFS could be improved.

   ➡ **Co2 reduction by 1/10 ~ 1/20 could be possible at a port**

2. Even we have all the containers information, we still need detailed information for further improvements
   - Standardization is necessary to collect information inside CFS/ICDs.
   - Dwell time reduction and less fluctuation could be possible using inside CFS/ICDs information
   - Container life-cycle management would improve logistics quality in supply chain

   ➡ **Another Co2 reduction could be possible, and in the future work**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