From a Paperless Port towards a Smart Port

Introduction

The Port of Barcelona (PB) started its mission to become a Paperless Port by Mid 90s. The port process reengineering, the use of electronic document interchange (EDI) among the different stakeholders at the port (private companies, authorities) and the establishment of the Barcelona Port Community System (PCS) named PORTIC in 1999. The setup of the PCS kicked off the roll out of the electronic processes using standard EDI.

In 2007 the Port of Barcelona achieved its aim and became a Paperless Port. This milestone was achieved when the majority of the haulage road companies at Barcelona Port decided to join the PCS and adopt the electronic process for the container gate in /out. However, it is needed to say that even though the process could be executed without papers, the terminals still required to implement a manual checking process at the gates. The terminal staff was placed into small cabins where they performed documentary checks, typed missing data and informed about the container lanes to the truck drivers.

The PB has already decided to go a step beyond, moving from a Paperless Port to a Smart Port. The vision of a Smart Port is a Port that uses digital technologies to enhance performance, to reduce cost and resource consumption taking care of people and being environmentally responsible.

In our vision a Smart Port should provide a set of Smart Services, which combines the following characteristics:

- **Intelligent and efficient use of current resources and infrastructures**: The Smart Services should optimize the use of current resources. They should seek for mechanisms that facilitate the re-use of the infrastructure. The setup of collaborative environments is relevant to allow the stakeholders to share resources. The resources may be human resources, IT Systems, premises, etc.

- **Economic Value**: The smart services should create a clear return of the investment and produce economic value through a cost reduction or a new source of income.

- **Environmental Sustainability:** The services should take into consideration environmental issues. They should contribute to reduce usage of limited resource and seek for the reduction of the CO_2 footprint.

- **Health Care Responsibility.** Millions of people work at Port Areas suffering tough conditions during their daily tasks. The Smart Services may not be aware of this fact and they should try to improve working conditions. For instance, by providing mobility services and technologies which allow people to work in better premises.

- **Governance**: The Smart Services should enhance the port management improving security, safety and other key items for the ports. Ensuring the availability, the traceability, the smooth execution of the port operations. The Smart Services should seek for a better

control of the tasks. In this way, it is key to have an efficient use of the human resources assigned to supervision tasks.

The current article presents two Smart Service developed by PB during the last two years. As it will be detailed, both two services follow a "Smart" approach and they have been addressed to optimize the gate in-out process at container port terminals by automating the gate tasks. The expected goals are listed below:

- **Time Reduction:** The gate in/ out operation at gate terminal were under the supervision of terminal staff and police officers. The personnel assigned to these tasks had to check the hard copy documentation or the information prompted in their IT Systems against physical items like the container number, truck plate, trucker identification etc. The control process took time and slowed down the gate in/out operation. Moreover, it provoked truck queues at lanes with its negative impact on cost, time and pollution.
- **Secure Operations:** The supervision and manual tasks were not free of errors and they were harder to follow up and trace them. The setup of automatic control at gates should guarantee the reliability and security of the port operations. The new systems would check that the operations were fully authorized.
- **Cost Reduction:** The gate automation would have a direct impact on the reduction of the staff assigned to gate control. Besides, the gate process time would be reduced; queues and pollution would be also alleviated.
- **Improvement of working conditions:** The people in charge of the supervision had to work outside or placed in small cabins. The gate automation has allowed to move people to well equipped control offices.

In order to develop the services, The PB has combined smartly a Collaborative Information system (PCS), digital and physical sensors (OCR, LPR) and Terminal Operating Systems (TOS)

Smart Gate-In Process

The enhancement of the container gate-in process was undertaken by Terminal Contenedores de Barcelona (TCB) at PB. The improvement consisted in the installation of an Self-Service Terminal where truck drivers could validate themselves the incoming operation. The Self-Service Terminals are shown in the figure 1.

The drivers type a 6 Character Code (PINCODE) or just validate a QR Image in their smartphones. The Self-Service Terminal is directly connected to the TOS, which validates the operation. Finally, the Self-Service Terminal informs about the container buffer (waiting area) to the driver and the barrier is lifted up. The initial process is described in the next section.

Initial Gate-In Process

The gate-in process mainly consisted of two parts. The first part, the Shipping Agent authorized the terminal to accept a container to be loaded on the vessel. The Shipping Agent sent an Acceptance Order to the terminal through the PCS (COPARN EDI message). The Acceptance Order might include several containers in the same document.

The second part consisted in the pre-notification of the incoming arrival of a truck by the haulage company. The haulage company notified the arrival of the truck informing the ship agent acceptance order reference, the truck plate, the driver identification, container ID, etc.

This announcement was transmitted through the PCS (COPINO EDI message). In some occasions, one pre-notification can include up to four containers in the same document. The terminal answered the pre-notification message with an OK or KO response message.

At the gate terminal, the drivers were used to present a printed copy of the notification. Due to the fact that the container ID and the seal were unknown at the moment of sending the pre-notification, the driver had to write them down on the printed copy. The terminal staff had to retype such new information in the TOS to complete the entrance.

The whole process presented some hazards, which made impossible to leave the gates unattended:

- The physical operation had to be checked. The container ID, truck plate, driver ID had to be checked against the electronic documentation sent previously.
- One truck could be nominated to perform many operations at the terminal. The haulage companies could assign different services to the same truck for a period of time. The TOS had to identify which of the standing operations of the truck was going to be executed.
- The container identification and seal number were not informed in the notification. The terminal staff needed to type them at the gate.
- Some drivers arrived at the gates with a pre-notification being rejected or left unanswered by the terminal.

New Process

As mentioned before, TCB set up a new gate management system, and Self-Service Terminals (kiosks), OCR sensors and card readers were installed.

The aforementioned process was also slightly modified. The PINCODE was successfully introduced as an affirmative response of the notification. The TOS now creates the PINCODE and sends it through the PCS to the haulage company. The PCS sends the PINCODE in many ways and formats, even as a QR Image.

To speed up the process, the haulage companies and terminals agreed on amending the pre-notification to require informing the container identification and the seal number as soon as they are known by the driver.

Drivers can use the Transportic special app for smartphones to control transport orders, receive and store PINCODES (as QR images) and report container and seal data on the spot.

Figure 1 Transportic app – screen for reporting Container ID and seal number.

The PCS automatically forwards the data reported by the truck drivers to the other operators in the chain (customs agents, forwarders, ship agents) for them to update systems and prepare for the next steps in the workflow (customs clearance, shipping instructions,

container load list).

Once the drivers arrive at the gate terminal, they type the PINCODEs assigned to the operation they want to perform and also introduce their magnetic card for their identification. Terminals are prepared to handle up to 4 operations (each one with a specific PINCODE) for one truck visit. The lectors disposed also read the truck plate and the container number. After checking all the information in the TOS, the Self-Service Terminal informs the driver where to head the truck and the barrier is lifted.

Figure 2 Self-Service Kiosk at Terminal Gates.

Benefits

- The dwell gate process time reduced from 4 minutes in average to 1 minute and 30 secs. In case of using the QR the time is reduced to 1 minute.
- The electronic documentation is automatically checked and manual errors have been eliminated.
- Terminal staff has been reduced and moved from the small cabins to a control office that are much better conditioned.
- The drivers have the guarantee in advance that they will be able to perform the service with the PINCODE.
- Haulage companies can optimize transport services more easily, combining pick-up and delivery operations under one truck visit to the terminal, as they only need a PINCODE for each operation – reducing even further queuing time, transport costs and environmental impact.
- The overall "export" workflow is improved, speeding up documentary processes that rely on receiving container ID and seal information to proceed (customs clearance, shipping instructions and container load lists), saving time and costs to all operators involved.

Difficulties

The major difficulty was to convince the haulage companies that the PINCODE was going to improve and ensure the operations. After a short period of voluntary use of PINCODES, they were convinced of the benefits of the new process and accepted to use the system.

Smart Gate-Out Process

The container gate-out process is based on two major controls. One control is performed by Customs and the other one is done by the Terminal. Customs checks that customs clearance has been done and terminal delivers the interchange document as a receipt of the port operation performed.

Initial Gate-out Process

Before performing a full container exit, the customs clearance has to be done and verified. The supervision process was undertaken by police officers who checked the customs clearance and also mark the container ID as "out". These checks blocked the exit gate, as the drivers had to get off the truck and wait for the control.

New Process

The Port of Barcelona (PB) has carried out a significant improvement installing automatic exit lanes at the two major container terminals, TCB and Best. The new solution adopted by PB relies on an unattended system. The new system is named SICAD and the Port Authority manages it. The solution has deployed a service named Virtual Gate. The Virtual gate reproduces in real time what it is happening at the gates. In this manner, as soon as a truck gets into the terminal, the system is aware how the truck is going to leave the terminal. This information is available for the police officers who are entitled to mark a container if they precise to perform any further check. At the same time, the SICAD system checks in the Customs System if the container can leave the terminal. The status information is sent continuously and in real time to TOS.

TCB has installed a new gate kiosk that performs OCR container identification and the truck plate number is recognized thanks to LPR. The two sensors execute the last checks before proceeding to exit the gate and the interchange document is printed. At Best Terminal, LPR readers have also been installed to read container IDs.

The TOS controls the barriers and lifts the barrier when the container is authorized or keep it closed if the container has been marked by the police or it cannot leave for other purpose.
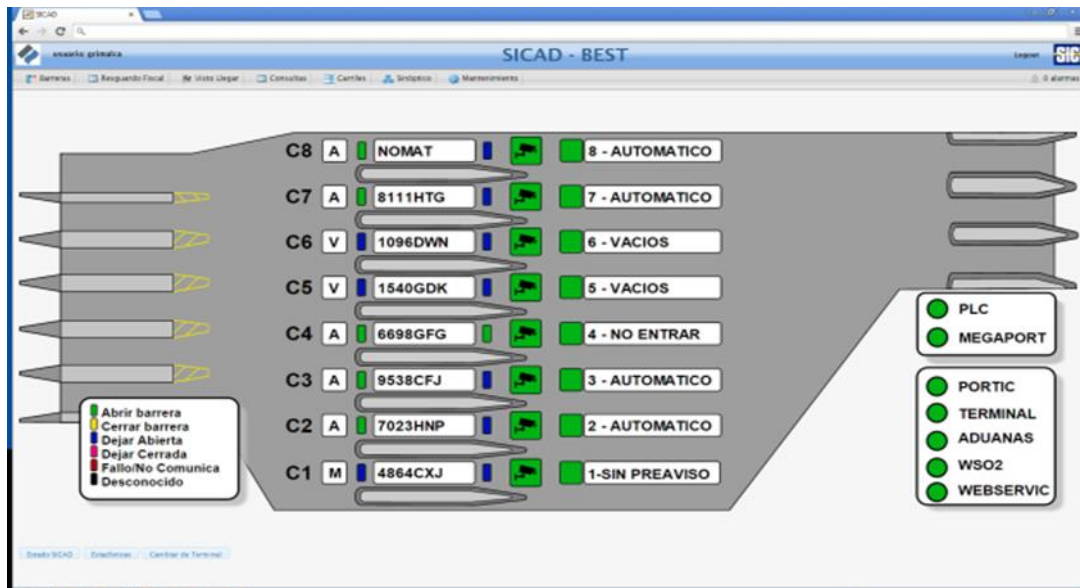
Figure 3 Virtual Gate

Benefits

- Similar to the previous case, the gate automation has allowed for a better control and requires now less human resources. The system has allowed assigning police officers to other tasks.
- Estimated time reduction of terminal dwell time for truck drivers is around 10%.
- More important though than the absolute time decrease is the significant improvement of truck driver satisfaction with general performance at container terminals. This fosters willingness to collaborate on new process improvement projects among haulage companies.
- Last but not least, avoiding the switch off / on of the trucks engines has contributed to reduce the pollution and save time.

Difficulty

The major difficulty to be overcome was to convince the Customs Authorities that the system would guarantee the security and also convince the police and truck drivers.

Final Summary

As it is been shown, the Port of Barcelona is heading towards a Smart Port reusing the current information, sensors, technologies blending all together in a collaborative environment to achieve intelligent efficient solutions.