Sustainable Operations for Airport Warehouse Cargo Management

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Nomenclature

ACRP	Airport Cooperative Research Program
AWB	Airwaybill
ETV	Elevating Transfer Vehicles
KPI	Key Performance Indicator
LD	Lower Deck
MD	Main Deck
ULD	Unit Load Device
SLA	Service Level Agreement

1 Introduction

The sustainability concept is not suitable only for operational or construction companies, but it is also essential all over the world precisely. Connecting the airports through the airline bridges together has boosted negative environmental effects all over the world. Besides those environmental effects, there are operational,

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social, and economic effects as well. The main pillars of sustainability for sustainable decisions can be listed as, caring for the environment and financially strong development plans. Sustainability advice will add value to warehouse operations (Dalkiran, 2018).

The ACRP (Airport Cooperative Research Program) study focuses on three sustainability areas: social, environmental, and economic airport practices. The results show that environmental sustainability is a key priority for airports, currently and in the future. The ACRP Airport Sustainability Practice report outlined sustainability obstacles from the most challenging to the least. In that order, these obstacles include funding, staffing, management, culture, and training (Asinjo, 2011).

The airport warehouse operations consist of receiving, storing, picking, and shipping cargoes, in suitably adapted places. For this purpose, and under organizational and technological conditions. Therefore, the airport warehouse process includes such sub-processes as receiving, storage, picking, and shipping. The airport cargo warehouse processes may take many different forms and include multiple sub-components. Functions and tasks of the logistics facility determine the selection and appropriate connection of this process. Each airport cargo warehouse process component is characterized by an appropriate sequence of actions that have to be performed to complete given goals and objectives (Klodawski et al., 2017).

Correct operation of warehouse facilities allows the realization of their logistic tasks at an appropriate and adequate customer quality level. Accordingly, it determines validity, cost-effectiveness, and the need for their functioning in supply chains. Therefore, attention in the literature is given to cases associated with the design of storage facilities as well as the modeling and organization of their warehouse processes (Baker & Canessa, 2009; Gu et al., 2010).

Analyzing airport cargo activities such as different shipments and special handling is essential because each shipment and special handling types require different working standards and service level agreements (SLA) parameters. It is important to meet SLAs with customers. Companies must be successful in fulfilling service-level agreements with users (customer perspective) (Rahman, 2013). Basic working standards must be measured, captured, and analyzed for defined activities to understand basic standards with measurements. Analyzing the impact of change in standards on SLA compliance and capacity utilization, actual working standards will be amended, and outputs will be analyzed post-implementation. According to those analyses, local standards can be set. Necessary actions affecting personnel, capacity, and customers must be taken based on the standard procedures to ensure standardization of daily critical operational decisions. For resource planning, existing manual planning systems should have re-evaluation. Handling companies should ensure that the manual system is used in regular practice.

Karkula (2014) analyzed the application of simulating a manually operated distribution warehouse characterized by complicated and dynamic processes. According to the author, simulation and models are needed to fulfill the challenges of the transportation and logistics problems of today and the future. One can say that during the analysis of the literature, it is possible to find that many of the suggested solutions concern specific issues and they often take into account one of the criteria of formulated tasks optimization (Karkula, 2014).

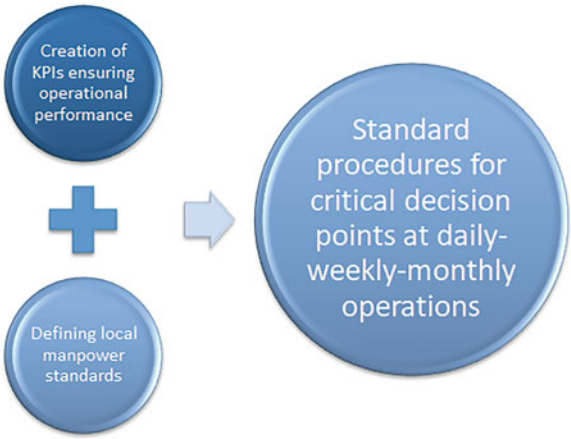

Fig. 1 Cargo operations standardization – first-phase scope

Rostering programs are based on systems and cover demand. If there is a need for rostering updates, absenteeism and communication between operational management and planners should be done. Rostering mistakes such as labor law, contractual requirements, and unequal workload distribution should be eliminated. Handling companies must find a real-time management system based on cargo operational needs. Implementation of the system must be complete for operations.

In this study, four airport cargo warehouse processes were examined. Buildup, breakdown, acceptance, and, delivery activities were focused on and measured during peak hours. These process steps are recorded manually. Cargo types, pieces, and tonnages were noted. Also, the types of equipment, agent, worker driver, and worker numbers used were measured. Their start and finish time stamps were recorded. The scope of these activities is summarized in Fig. 1.

A comparison table has been developed to compare measurements in order to determine the amount of human resources required to meet each criterion with various staffing arrangements. The current applied standard is defined, and suggestions will be created for improvement based on financial outcomes in the following studies. Also, the creation of KPIs ensuring operational performance will be completed. Manpower standards will be defined according to these measurement results and analyses. These measurements will help management to make legal and sustainable airport cargo operational decisions during daily, weekly, and monthly operations.

In Table 1, airport warehouse cargo acceptance and cargo delivery process are explained step by step. In the cargo acceptance process, the worker brings cargo to the edge of the truck, loading pieces on the euro pallet. The worker offloads from the truck with a hand lift, or the worker driver offloads from the truck with a forklift. The distinction between a worker and a worker driver is that the latter holds a handling equipment driver's license. After offloading process, an agent has to complete the weight, volume, and documentation check. For the cargo delivery process, the worker driver brings the cargo to the final delivery area. The security staff/handling

Table 1 Warehouse cargo acceptance and delivery steps

Process	Explanation of task	All process resources
Cargo acceptance	Bringing cargo to the edge of truck, loading pieces on euro pallet	A, W, WD, H, F
	Offloading from the truck with a forklift or handlift	A, W, WD, H, F
	Weight and volume check	A, W, WD, H, F
	Documentation check	A, W, WD, H, F
Cargo delivery	Bringing the cargo to the final delivery area	A, SA, W, WD, H, F
	Cargo clearance by security at the final delivery area	A, SA, W, WD, H, F
	Moving cargo to the edge of the truck	A, SA, W, WD, H, F
	Loading cargo to the trucks	A, SA, W, WD, H, F

A Agent, *W* Worker, *SA* Security Agent, *WD* Worker Driver, *H* Handlift, *F* Forklift

Table 2 Warehouse cargo buildup and breakdown steps

Process	Explanation of task	All process resources
Buildup	Bringing slave pallets to the area	WD, W, CA, S, H, F
	Shifting ULD/baggage cart to the buildup area	WD, W, CA S, H, F
	Moving euro pallet to the buildup area	WD, W, CA, S, H, F
	Pallet buildup by worker/supervisor	WD, W, CA, S, H, F
	Covering and netting by workers	WD, W, CA, S, H, F
Breakdown	Bringing slave pallets to the area	WD, W, CA, S, H, F
	Shifting ULD/baggage cart to the breakdown area	WD, W, CA, S, H, F
	Pallet breakdown by worker/supervisor	WD, W, CA, S, H, F
	Moving euro pallet to binning area	WD, W, CA, S, H, F

WD Driver, *W* Worker, *CA* Cargo Agent, *S* Supervisor, *H* Handlift, *F* Forklift

company's agent must ensure cargo clearance, pieces, tonnages, and documents at the final delivery area. The worker/worker driver should move the cargo to the edge of the truck with a hand lift or forklift.

In Table 2, the buildup and breakdown processes are explained. For buildup, the worker driver brings slave pallets to the area. After shifting the ULD/euro pallet/baggage cart to the buildup area, workers start the buildup. Covering and netting by workers is the last phase of the buildup process. Agent records all data during the buildup process. The breakdown is the opposite process of buildup. The worker driver brings slave pallets to the area and shifts the ULD/baggage cart to the breakdown area. Workers complete the pallet breakdown process, and the agent accepts the cargo to the cargo warehouse during the breakdown process.

2 Workforce Requirements for a Defined Process

Standard measurements will include all related status properties, such as pallet is on the station, the pallet is built up, covered with a net, and recorded in the system are measured. These measurements must be recorded as the same as in all subsidiaries. Records should have the below properties:

- Start time
- End time
- Cargo pieces and tonnage
- Cargo type
- Personnel count

Cargo terminologies such as main deck (MD), lower deck (LD), and unit load device (ULD) are used to define processes. Unit load devices (ULDs) are used to load passengers' checked baggage and air cargo for wide-body aircraft operations (Lu & Chen, 2012). The main deck is the highest deck running the full length of a vessel. The lower deck of an aircraft is usually used as cargo space. The various cargo sections are known as the hold and differ according to their position in the aircraft. The forward hold is located in the front section of the aircraft (in front of the wings) (Lurkin & Schyns, 2015). The term "Bulk" is used to define the loose type of loading, the cargoes load without unit load devices. Bulk cargo typically refers to cargo that is not containerized, such as pallets with stuff on them and a cargo net. Trucks are large, heavy road vehicles used for carrying goods, materials, or troops – a lorry. Forklifts are multi-functional and highly maneuverable trucks designed to transport and tow cargo and baggage at the hangar, warehouse, and airport. Handlift trucks are the solution to moving materials, boxes, and other items without strain. A handlift is designed to be used at industrial sites and in commercial applications, warehouses, and offices (Horberry et al., 2004).

Standards with different times and personnel relations should be measured. The below list can be used as an example. The minimum number of measurement requirements for each activity in different settings are listed below:

- 20 measurements for loose/euro pallet cargoes acceptance with different numbers of workers, agents, and types of equipment
- 20 measurements for loose/euro pallet cargoes delivery with different numbers of workers, agents, and types of equipment
- 20 measurements for MD/LD/loose/euro pallet buildup with different numbers of workers, agents, and types of equipment
- 20 measurements for MD/LD/loose/euro pallet breakdown with different numbers of workers, agents, and types of equipment

Measurements were recorded and analyzed for different cargoes, pieces, and tonnages. For cargo acceptance and delivery processes, trucks are separated into small trucks, medium trucks, and large trucks. For buildup and breakdown, the same division has been made for other types, such as MD, LD, loose, and ULD. It is

important to take at least 20 measurements. The number of metrics and scenarios are important to better understand how the presence of too many sub-processes in cargo acceptance, cargo delivery, buildup, and breakdown processes responds in different teams.

3 Relation of Continuous Measurement with Standardization and Performance

In the first phase, the scope of this study was set to reach manpower standards, shift performance, and efficiency of the team to the defined KPIs. Also, standardization of critical decisions with a predefined path. Following are some examples:

- MD pallet with 2 worker +1 forklift +1 Agent 30 min
- MD pallet with 3 worker +1 forklift +1 Agent 15 min
- MD pallet with 4 worker +1 forklift +1 Agent 10 min

The same measurement was made for other types such as MD, LD, bulk, ULD, small truck, and big truck. A minimum number of measurements for each activity was analyzed with different settings, for example, 10 measurements with 2 workers, 10 measurements with 3 workers, and 10 measurements with 4 workers for buildup or breakdown.

In the acceptance of cargo process, the average truck tonnage is 1.5 tons and the fastest truck process time is 30 min. In case of import, average weight of the euro pallet is 0.25 tons and the average euro pallet unit per delivery is 2.5 tons. The delivery gate process time per euro pallet is 2.7 min.

In case of export, the average MD/LD tonnage is 2 tons. The fastest MD/LD process time for buildup is 35 min with 4 workers and 1 worker driver. For the import side, the average MD/LD tonnage is 1.8 tons. The fastest breakdown MD/LD process time is 21 min.

4 Conclusion

All the results and analyses of warehouse processes' measurement support the warehouse management team's guide through their cost, social, and environmental targets. It is a matter of organizational arrangement and lost-profitability analysis to pursue those sustainability targets.

The acceptance, delivery, buildup, and breakdown processes were detailly examined in this airport cargo warehouse study. Pieces, tonnages, manpower, and equipment details were noted for each measurement. Manpower and equipment's start and finish times were measured. Measurements data were recorded during peak hours. According to these measurements, KPIs configurations are completed. Acceptance

activity starts with receiving the first pieces of AWB. After receiving the cargo, the agent measures and enters the volume and weight of the shipment, and the activity ends with the truck leaving the cargo warehouse dock. For each ton, 20 min is acceptable. For delivery orders lead time, the process starts when a customer requests the cargo at the delivery gate of the warehouse. When all pieces of the shipment are completed, the agent releases the last pieces of the shipment and confirms the delivery. 15 minutes is acceptable until 1 ton. If the shipment is more than 1 ton, 1 h for each ton is acceptable. According to 20 breakdown process measurements, 1 h and 1 worker are enough for 2.5 tons. In case of buildup productivity, the failure of the team to focus on a single flight in the operations department, the fact that the construction was started due to the entry of the loads/inspection or the paperwork, and the interruption due to operational reasons are the main reasons for the prolongation of the process. The buildup process was completed with two workers in 30 min for a container and this is acceptable.

Acceptance, delivery, buildup, and breakdown of airport cargo warehouse activities were the first phase. After the completion of this phase, another airport cargo warehouse activity can be analyzed, such as racking, de-racking, and ETV. These warehouse process measurement data will be simulated later on. These simulation studies will identify bottlenecks and determine and improve the efficiency of the airport warehouse processes. Another group of issues relating to the internal transportation of handling equipment is a problem associated with the scheduling of transportation tasks. The objective of the optimization is to minimize the total travel time of the forklift during the realization and receiving of all transport orders. Also, shift planning will be analyzed. It's aimed to minimize the overtime working hours of the personnel.

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