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POSSIBILITIES OF INCREASING THE EFFICIENCY OF LUGGAGE TRANSPORTATION AT THE AIRPORT

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Abstract:
Following the relaxation of measures in the post-Covid era, air travel came to a point where the sudden rise in traffic made it difficult to react quickly, particularly in the handling process of passengers and their luggage. The article discusses ways to improve the effectiveness of the baggage handling system in order to reduce critical situations during the check-in procedure after a sudden reduction in staff. Modernization and improvement of baggage sorting with the suggestion of technological choices for improvements, clear criteria for the allocation of individual technical devices in the check-in system, and logical management of activities are only a few of the options.

Key words:
technical handling, baggage handling, efficiency in the baggage handling system, improving

INTRODUCTION

One of the crucial steps in the airport's ground handling process of aircraft is the processing of baggage. Inbound baggage handling, which combines the flow of baggage from local airport check-in counters when delivering baggage to departing aircraft, the baggage of incoming passengers in transit to another flight, and the handling of baggage of passengers arriving at the destination are the three main processes that it consists of.

The quantity of damaged and, notably, missing baggage is used to evaluate the quality of baggage handling. Every piece of misplaced luggage diminishes the reputation of the airport and may result in financial compensation for the airlines. Missing baggage necessitates

additional handling procedures. The number of staff decreased as a result of the decline in air traffic and the associated decline in handled baggage at airports. In comparison to the beginning of the pandemic, Oxford Economics predicts that 2.3 million fewer people were working in aviation globally in 2021 (Oxford Economics, 2022). Resources will likely be below pre-pandemic levels for some time after this drop in aerospace employment. The ability of the business to meet passenger demand may continue to be hampered by hiring delays brought on by the time required to find, train, conduct security checks, and fulfill other obligations.

Fig. 1 *Hundreds of unhandled bags at Heathrow Airport - Terminal 2, (BsfQH, 2022)*

Since the spring of 2022, there has been a rebound in air travel and an overall increase in volume, which has led to a breakdown in the baggage handling system at numerous airports (BsfQH, 2022). There is an increase in cases of delayed and misplaced luggage, and tourists are experiencing issues never before seen. A startling 135% more checked baggage was lost, damaged, or delayed as a result of this alleged "airmageddon" than it was during the same time period in 2021. There have been 147% more consumer complaints overall against airlines (New York Post, 2022).

The design of the airport and the capacity available determine how complicated the luggage transfer operation will be. Therefore, a tool to support decisions about the mode and location of baggage distribution and transportation must offer quick fixes during routine operations. New modes of transportation, the use of partially automated system prototypes, as well as verification-simulations of the aforementioned tasks, can all be alternatives that, in the end, result in significant cost savings and higher levels of safety.

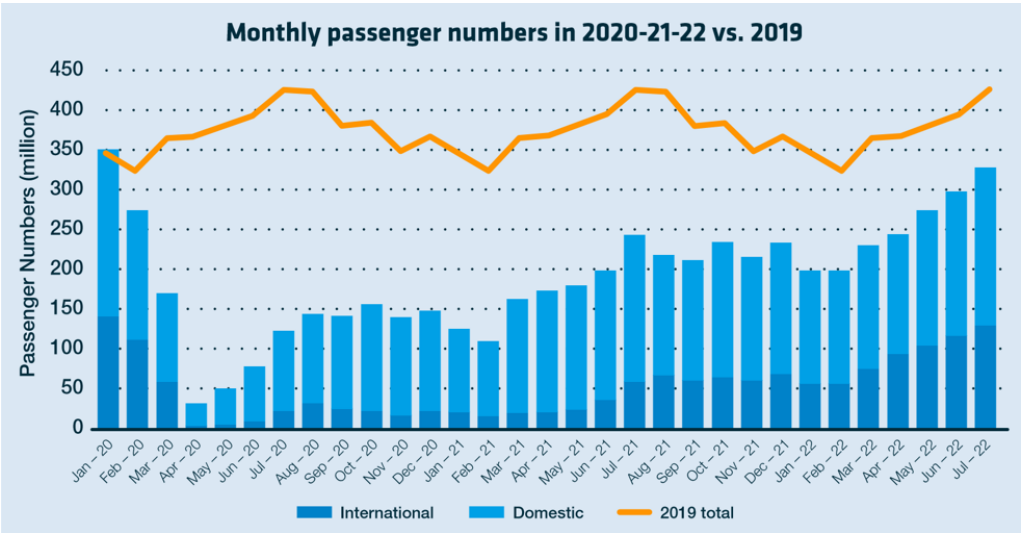

Fig. 2 *Monthly passenger numbers in 2020-21-22 vs. 2019 (Uniting aviation ICAO 2022)*

Baggage handling is seen by passengers as a key component of airport and airline quality. There is an ongoing demand to enhance and streamline the baggage handling system due to rising competition. Passengers were kept secure during the epidemic thanks to self-service and contactless technology solutions integrated with existing systems that enabled airports to comply with COVID social distancing standards. This means that the effectiveness of baggage systems and processes has never been achieved for the success of airports. It also means that automation is the need for inevitable and continuous asset exchange (driven by new security standards such as ECAC Standard III. (ECAC, 2022), and the increased demand for EBS are all contributing factors. For airports, investors, operations teams, and other stakeholders, baggage poses numerous issues. The implementation of an early baggage drop-off location at check-in, connected innovative CUPPS technology, and an advanced Early Bag Store (EBS) to organize delayed baggage are some solutions (IATA, 2018). Regardless of the size of the airport, the effect on the flow of bags, or the impact on the passenger experience, there are a variety of techniques we may investigate to enhance and make BHS at the airport more efficient (AiQ Consulting, 2022 & Airport Technology, 2022).

2. POSSIBILITIES FOR IMPROVEMENTS IN THE BAGGAGE HANDLING SYSTEM

The area allocated for unit load device (ULD) installation is outlined in the Makeup Point Plan (MUP). Additionally, it aids in understanding and managing logistics and resource allocation. It gives airports more insight into the movement of baggage, enabling them to plan ahead and build airports that are more effective in terms of capacity and costs. It is crucial to analyze the flow of baggage throughout the entire system while simulating it using actual timetables and presumptions to build a calibrated model. Based on this, capacity plans for baggage check-in, equipment demand for luggage, and screening equipment needs are assessed (AiQ Consulting, 2022).

For airports, asset replacement is a constant and necessary task. New security standards that have already been put in place have recently influenced held baggage screening (HBS), necessitating the replacement of most of the existing screening tools. With an emphasis on efficient planning for capacity assessment of the current process, modeling, and impact mitigation, increased demand for Early Bags Storage (EBS) may also necessitate an upgrade to increase efficiency and capacity as well as embrace new challenges and technologies for handling systems. Identifying prospective risks and effects as well as assisting in the creation of plans to reduce infrastructure, work, and process risks are all part of the subsequent forecasting of potential threat scenarios. Complete departure and arrival solutions, check-in counter and kiosk management, luggage handling areas, baggage claim, and departure/arrival area management are all projects (Szabo S., 2022).

2.1 Carousel Allocation and Scheduling Rules

The Makeup Point Plan of the carousel conveyor belts, which enables the sorting of outgoing luggage, is decided and marked for the benefit of efficient and trouble-free operation of baggage sorting. The MUP is where luggage may be loaded into trolleys, containers, and palletizing units, also known as Unit Load Devices or ULDs, which are used to convey luggage. Each of these areas has a unique identification that serves as the foundation for resource planning. All aircrafts carrying luggage are given one or more positions, and the Ground Handling (GH) agents are informed daily of their identifiers for the next day through FIDS (Flight information display systems) screens and other communication channels by the Airport Operation Control Center (AOCC).

Temporary adjustments may be required, for example, in the following cases:

a) flight delay (departure, arrival),
b) flight cancellation,
c) changes in aircraft loading systems (a ULD aircraft is used for the flight instead of a bulk-loaded aircraft),
d) critical, unforeseen ground handling staffing issue.

However, individual changes cannot affect the activity of other ground-handling components (T. C. Barth,, D. A. Pisinger, 2021).

Procedures for significant and/or permanent changes and modifications may be necessary in the following cases:

- significant operational changes within the flight schedule (change of flight schedule or aircraft types),
- GH requirements regarding the streamlining of activities (new arrangement of MUP within a given GH area of operation, but between carousels),
- Amendment to the ground handling contract with the airline or change of GH agents,
- New airline and/or new entry into GH,
- significant maintenance or development activity,
- An unexpected technical event or an extraordinary event has a significant impact on the operation of the infrastructure.

In such circumstances, the initial MUP allocation strategy will be examined, and if required, the luggage sorting logic will also be modified. The BHS unit in charge of capacity planning will assess the complete MUP allocation plan before switching between time periods based on the anticipated traffic circumstances and the unit's prior experience.

The review process consists of the following phases:

1. Development of a draft plan for the relevant schedule period.
2. The plan must be submitted to interested parties for comments.
3. Obtaining feedback and preparing the final plan.
4. Issuance of the final plan.
5. Permit.
6. GH agents will prepare any requests regarding adjustments to the MUP allocation plan and submit them to dispatch; checking flights not foreseen in the schedule from the point of view of the MUP allocation plan and making possible corrections, if necessary.
7. the MUP allocation schedule is completed with all changes in accordance with any flights not listed in the schedule,
8. Review the implementation of the plan with stakeholders and make any changes if necessary.
9. Reviewing the implementation of the plan with stakeholders and finalizing the plan for the rest of the planning period.

Figure 3 illustrates the many steps involved in the baggage handling process that take place between the arrival of the arriving airplane and the departure of the connecting flight. These activities form the basis of the research problem (T.C. Barth, J.T. Holm, J. L. Larsen, D. Pisinger, 2021).

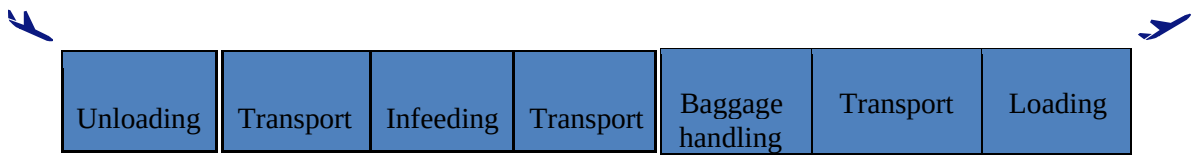

Fig. 3 *Process chain of transfer baggage handling at the airport (BEUMER Group, 2022)*

2.2 Modernization of baggage sorting systems at airports

The airport's baggage sorting system plays a crucial role in daily operations. Implementing effective and hassle-free baggage sorting systems is essential to maintain customer satisfaction and positive relationships with airlines. In 2021, the market for airport baggage handling systems was valued at USD 6.7 billion, and by 2030, it was expected to reach USD 16.1 billion. Based on the findings, automated sorting conveyor systems are by far the most common in terms of security, effectiveness, and sorting precision (J. C. Rijsenbrij, J. A. Ottjes. 2008).

The luggage is safely delivered to the intended location at the airport by the airport conveyor. The majority of baggage handling systems work like automated conveyor belts that move items and baggage from one place to another. Airports have conveyors all over the place for moving luggage, such as behind the check-in desks prior to departure, past the security check for checking carry-on bags, and in the baggage claim areas following the arrival:

- handling conveyors
- security clearance
- general transport/combining/collecting/dispensing conveyors
- crescent palette, overlapping slanted and tilted carousels
- timely luggage storage
- sorters with hinged trays, luggage tray systems, vertical sorting units

During check-in, airline staff will place specific barcodes on the baggage, which will be automatically scanned en route to send the luggage to the correct destination. Then, upon arrival, each aircraft unloads its baggage into the early baggage hold before sending the baggage to the return area.

While automation conveyor and sorting systems are used in various manufacturing industries, airports use specialized baggage handling companies to install specific complex systems for transporting baggage and passenger cargo. Losing a passenger's luggage will result in poor customer service ratings and lost revenue, while negatively impacting the reputation of the airline or airport. An optimized and automated sorting conveyor system will improve operational efficiency and passenger satisfaction. New sorting technology within the design of automated sorting conveyors will improve efficiency and require less manual intervention. Depending on the size of the airport, different conveyor systems can be installed and connected in each required area (M. Frey, F. Kiermaier, R. Kolisch. 2017).

Floor conveyors can serve the general purpose of automating of sorting passengers' luggage. By connecting separate belts and lines, floor conveyors can ensure the safe and fast transportation of luggage within a comprehensive baggage handling system. Custom designs for floor conveyors can be created to meet airport specifications while keeping operations running smoothly. Any airport floor conveyor system is modifiable with additional robotics to assist in the transportation of airport baggage. For example, robotic conveyors can be applied specifically to Automated Storage and Retrieval Systems (ASRS) for multi-purpose storage and retrieval, or as scanners/coded cameras along conveyor belts.

IATA's pioneering "InBag" program will help achieve a 20 percent improvement in the efficiency of baggage operations. IATA estimates the cost of all baggage operations at $29 billion per year. On the other hand, ancillary revenue from baggage is only $10 billion. Therefore, process efficiency and product innovation are important to reduce costs while improving customer service.

Baggage services are offered as an ideal scenario for the passenger:

1. Have the baggage picked up and then delivered to home/office and destination.

2. Tag the baggage at home with a home-printed luggage tag or electronic luggage tag, then use the express baggage drop-off facility.
3. Use the airport self-service to tag the baggage and then drop it off at the baggage drop.
4. Use regular registration.

The baggage is then processed at the airport in the most efficient way possible, with information about the baggage shared by all relevant parties responsible for its journey. The passenger is informed if there are any exceptions for his luggage - a delay or other problem - and is reconnected at the destination airport or hotel. Of course, the process is so smooth and flawless that everyone would choose to check baggage rather than carry a carry-on. This ideal process is possible but is not a matter of course for all travelers.

Pickup and home delivery

Two challenges often arise against baggage pickup and delivery. One is security, the other is customs. Neither is a convincing argument. All luggage is screened to ensure safe travel. Before this screening, all baggage can be a threat. Securing the bag before the checkpoint does not affect the security process, it just increases the cost. Customs could also view images of incoming baggage and capture it with passenger details. The real challenge is sharing baggage journey information in a standard way that allows local entrepreneurs to deliver a consistent product for baggage pickup and delivery. This is something that IATA can help with through the Industry Data Model (IATA 2022).

XML data model

The IATA Cargo-XML messaging is emerging as a preferred standard for electronic communication between airlines and other air cargo stakeholders such as shippers, freight forwarders, ground-handling agents, and regulators, as well as customs and security agencies. This new standard is based on multimodal and cross-border messaging and aims to:

a) facilitate cargo business processes;
b) fulfill customs requirements for Advanced Cargo Information (ACI) filing;
c) comply with security regulations like e-CSD.

XML also opens the door to a number of easy-to-use developer tools, making systems easier to implement and maintain.

Luggage tags printed at home

This is where regulation is a challenge. The European Customs Code does not allow anything other than the current regular baggage. Customs agencies and the European Commission are working with IATA to update the Customs Code to facilitate the new label design and processes. Electronic labels are subject to the same regulatory requirements as home-printed labels. There is also the added complexity of standardization at the interfaces between the airline and other air traffic regulators, passenger tracking, displays enabling intermodal travel, and exception processes. There needs to be electronic proof of baggage claim. Baggage claim confirmation via an electronic channel such as email, SMS or a smartphone app contains all the current information shown on the physical baggage claim statement, but without the necessity to print it. Replacing paper-based baggage claim documents with electronic ones brings industry-wide cost savings, plus valuable passenger contact information that can be used during disruptions.

The quality of airlines is currently also measured by baggage performance - the ratio of incorrectly handled baggage to passengers. This is not a fair measure of performance. First, it's too easy. The same ratio is used for an airline offering a transfer product and point-to-point carriers. The operations are completely different, so the same measure should not be used. The

similarity of the operations is the successful loading of baggage in the agreed loading time compared to the total number of bags. When the airline accepts the baggage, it takes responsibility for it. However, there are many parties involved in transporting the baggage and the proper arrangements must be aligned with the service level agreed upon between all of these parties. Standard service level agreements are already available in the IATA Airport Handling Manual. The challenge is to establish a standard set of measures that can be used to compare similar operations without requiring high manual effort (World Maritime University, 2019).

3. PROCESS IMPROVEMENTS

In the future, airport process authorities will have access to the raw radiation map from baggage screening at each baggage transfer point. Each party can then apply its algorithm to the map to generate an image suited to its needs. This will enable remote baggage control. The challenge then is to ensure that the baggage cannot be tampered with during the journey. Such improved recognition will allow authorities to choose how much baggage to check remotely, except when they face an increased level of security threat. If efficiency is increased during the transfer process, a significant amount of time can be saved, ensuring that stringent minimum connection times are met. Making security changes is never easy, and for good reason. The proposed remote security clearance mechanism allows the detection algorithms to be kept secret and allows agencies to focus their efforts where maximum benefit can be obtained.

During audits of IATA's Baggage Process Improvement Program, there were instances where more than five handling companies moved a single piece of luggage between two aircraft.

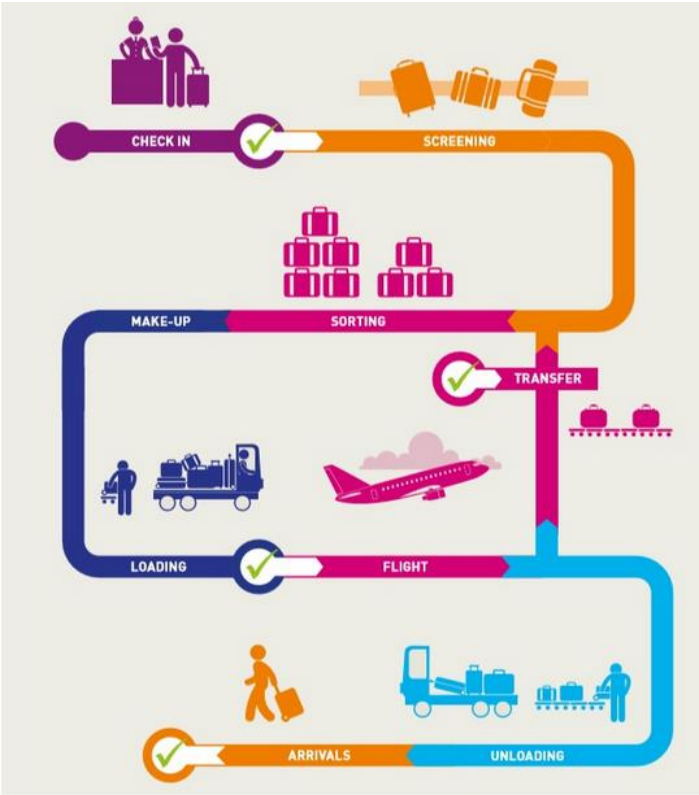

Fig. 4 *IATA resolution 753 mandatory tracking points (IATA)*

If airlines share a common process, the local baggage committee is responsible for determining how the process can be most efficiently managed. Processes should also have preliminary and subsequent conditions.

3.1 ICS Baggage Handling System

A hallmark of the ICS baggage handling system is the use of uniform carriers such as trolleys or bags (also referred to as trays). It is based on the idea that placing one bag in a separate carrier will prevent wheels, straps, or odd-shaped bags from getting caught in the conveyor system and causing jams. The baggage is loaded into the carrier at the beginning of its journey through the baggage hall and separated only at the very end, just before loading the ULD transport container or baggage trolley. ICS can run at high speed, making it the best technology for long distances. As previously mentioned, ICS technology has a modular design, with the carriers running around a loop of track. Some modern ICS systems can run in reverse, providing self-fixing routing capabilities. For airports with one or more terminals, for example, a trolley transport system is suitable. Its ideal application is for medium- and high-capacity sorting that requires medium-speed transport with a limited number of unloadings (A. Price, 2014).

Fig. 5 *Baggage handling trays (BEUMER Group, 2022)*

The trolley system is suitable for small and medium-sized terminals and systems, as well as connections between terminals. Its ideal use is comparatively for high-speed transport and lower capacity with high sorting complexity. ICS technologies offer many attractive features that can be used by the baggage handling systems of all airlines and airports. They add various improvements to operational baggage handling – such as unique traceability and scalability – while being cost-effective and energy-efficient solutions that can positively impact baggage performance at the airport (C. Torben, 2021).

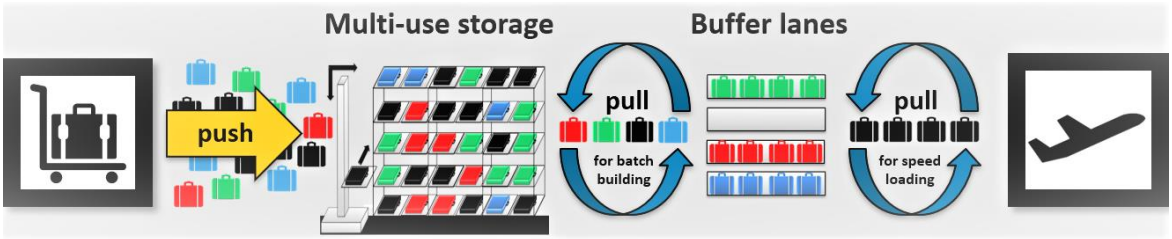

Fig. 6 *Batch building explained (BEUMER Group, 2022)*

As the name suggests, ICS handles luggage using an individual carrier such as a trolley or bag. Putting each luggage in its own bag reduces the possibility of wheels, straps or odd-shaped bags getting caught in the transport system and getting stuck during transport. ICS is

specifically designed as a closed loop that allows standardized carriers to flow through the baggage system with accurate tracking and predictability at higher speeds than conventional systems. With the intention of becoming a hub airport, this type of Baggage Handling System (BHS) was on Oslo Airport when looking for a replacement for the existing system. In addition to fast and efficient delivery, another key criterion was a system that is future-proofed to interface with tomorrow's technologies. To meet their needs, Oslo decided on the CrisBag BHS. As a comprehensive solution for the entire baggage handling process, this solution enables the processing of departure, arrival and transfer baggage within the same system with the required 100 percent tracking under all circumstances. The solution was designed from the ground up to be modular – as airports grow, change and adopt new technologies, they will need their BHS to change with them without disrupting operations. It can also operate with a very high level of redundancy to ensure stable baggage handling quality (J. C. Rijsenbrij, J. A. Ottjes, 2008).

4 RESULTS

The above-mentioned modern baggage equipment system contributes to the following:

- increased safety of passengers' baggage handling,
- the safety of work with luggage itself,
- minimizing damage to baggage during handling,
- elimination of cases when luggage gets lost during individual activities in the check-in process.

To introduce ICS at the airport, it is possible to use the existing infrastructure, but it is important during the renewal of airport equipment or new construction, to provide the most efficient spatial use of detection control and baggage handling resources. Based on technical comparisons, the advantage is to implement an ICS configured for common use by all airlines.

The system will feature a common check-in design with a two-step process:

a) Passengers print their boarding passes and baggage tags at the kiosk before placing their baggage on the bag at a scale, label, dispatch (SLD) unit, and the screening and indexing of baggage as they enter BHS is then automated, eliminating the need for airline staff to lift or handle luggage.
b) After check-in, each piece of luggage is loaded into separate carrier bags on the ICS and the information on the tag is linked to the built-in RFID tag inside the luggage, the label will be scanned by automatic 360-degree label readers located at each of the loading points.

Baggage can be 100% tracked and will remain in carrier bags during the automated security screening process, even when diverted by the security team for manual screening.
Tests carried out at airports in the EU and the USA evaluated:

- system monitoring,
- throughput, imaging, false alarm rate sorting options,
- the ability of the system to detect missing, unknown, and oversized baggage,
- the speed at which individual luggage is connected to its dedicated carrier bags.

In contrast to the conventional approach to baggage handling, it allows the joint use of one system by several airlines, which will allow a reduction in the number of computed tomography X-ray (CTX) screening machines, a reduction in trailers traffic and, above all, an efficient use of resources. The result is a very high level of energy efficiency combined with low operating costs (GMRC, 2020).

5 CONCLUSIONS

As it was already emphasized in the introduction, the problem with the baggage handling process during the increase in the volume of air traffic complicated the airport operation. Between 2020 and 2022, due to the rapid reduction in the volume of air traffic, airport and handling companies reduced the number of employees, which resulted in a difficult return to full operation, as new employees must go through security checks and, above all, must be trained.

The article elaborates on the issue and suggests possible ways to eliminate threats and increase the effectiveness of individual activities during baggage handling at the airport. The primary task is the organizational management of the process of baggage handling, clarifying the priorities and possibilities of the handling organizational unit. It is a task without extraordinary financial requirements, and improving the coordination of individual sub-tasks helps to facilitate decision-making and the smoothness of the process. Subsequently, we can introduce new innovative elements and technologies that also contribute to increasing the security and throughput of the entire system, from the possibility of submitting/receiving luggage, its screening (checking) to its loading/unloading from the plane, transfer and handing over to the passenger at the destination.

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