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Research Article

Sustainability of the Air Cargo Handling Process in the Context of Safety and Environmental Aspects

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In addition to passenger traffic, air cargo business is an important business for a global air transport industry. This means that Air Cargo Handling Process (ACHP) is important for any airport or cargo handling agent who provides cargo handling services. To qualitatively manage the ACHP, certain prerequisites must be met, such as competent cargo staff, procedures, cargo information system, infrastructure with enough capacity, and process management. The objective of research presented in this paper is ACHP and its complex structure but in the context of safety and sustainability. Using of several scientific methods of cognition, the authors research the structure of ACHP and safety, and ecological aspects of the process, too. The result of this research is the safety and environmental aspects of the process which are of significant importance for process functionality as well as for the quality level of service that meets customer requirements and to the sustainability of process. Results show that there is a significant impact of the environmental and safety aspects specific to particular activities in ACHP and that they affect the reliability and functionality of the whole process, its profitability, and competitiveness. This points to the need for ACHP to be viewed in context and to understand ACHP sustainability matters and sustainability components.

1. Introduction

The ACHP, which as a result has a cargo handling service at airports, can be provided by the airports themselves (usually at airports with traffic up to 50,000 t annually), or by specialized companies, i.e. Cargo Handling Agents, or by Airlines as self-handling. According to the Ordinance on the Provision of Ground Handling Services (Directive 96/67/EC) [1], when the cargo traffic of an airport reaches 50,000 t or more annually, the market for these services should be liberalized, in order to enable another service provider, that, under the terms of the Regulations, it may provide cargo handling services as part of a competition.

Ashford et al. [2] said that on closer examination of the development of air cargo indicates a number of factors are involved, such as gross domestic product, cost and other factors.

According to the International Air Transport Association (IATA), 52 million tonnes of cargo have been carried worldwide in 2018. By weight, it is less than 1% of world trade, however, it is more than 35% of world trade value, accounting for about US $ 6.8 trillion annually, or US $ 18.6 billion in value of goods every day. Air freight (cargo) transport accounts for an average of 9% of total airline revenue, double that of first-class passenger revenue. Directly and indirectly, the air cargo business provides around 32 million jobs worldwide. To support this critical business, IATA is committed to deliver enhanced value for the industry by driving a safe, secure, profitable, and sustainable air cargo supply chain [3].

Demands from consumers and the industry for faster transports of goods have fuelled the rapid growth in air cargo transportation during the previous decades. Hailey and Jonasson [4] concluded that it has been shown to be an important means in the movement of goods in support of supply chains on a global scale.

When it comes to air cargo transport, competition among airports is very strong, especially in relation to intercontinental (long-haul) traffic. Airports winning in this market

competition are the ones having: competent staff, appropriate cargo infrastructure, developed route network, good traffic links of the airport with the railway, technology implementing latest developments, quality based on ISO standards, IATA projects such as Cargo 2000 (C2K) management system, e-freight technology, iQ, and the like. Cargo iQ is an IATA interest group with the mission of creating and implementing quality standards for the worldwide air cargo industry. For that reason, every handling agent, or air cargo handling service provider, makes efforts to improve the quality of the process in all elements, in order to be competitive in the market.

Chung Hu et al. [5] concluded that most research that has studied the quality of service provided by the air cargo industry has concentrated on forwarders or air cargo logistics providers.

Hlavaty and Kraus [6] described that transportation of cargo is different from transportation of passengers, especially the procedures of handling are different. Actions which have to be performed during technical handling of passengers' aircraft are, inter alia, boarding of passengers, loading and unloading of baggage, loading and unloading of cargo, catering supplies, and cleaning of aircraft. On the other hand, activities performed during business handling of cargo aircrafts can include only crew boarding and loading and unloading of cargo.

Due to the high degree of regulation of air traffic, it is subjected to a large number of international, and national standards, directives, laws, and regulations. Accordingly, and further to the main postulate of air transport, "safety first" should be the same in the cargo transport segment in accordance with documents such as:

(1) ICAO—Annex 16—Environmental Protection; Annex 17—Security; Annex 18—The Safe Transportation of Dangerous Goods by Air; Annex 19—Safety management [7],
(2) EASA—Regulation (EU) No 376/2014 and Commission Implementing Regulation (EU) 2015/1018,
(3) IATA—Dangerous Goods Regulations (DGR), Live Animals Regulations (LAR), etc.
(4) National regulation.

What is new in this paper that is conclusion that the safety and sustainable ACHP can be established if a system for managing the impacts of individual safety aspects and environmental aspects is established and if it manages each element of safety, environment, and quality components. In these circumstances, it is possible to achieve the synergy of economic, environmental, and social factors necessary to ensure functionality as well as the safety and sustainability of ACHP for a long period.

2. Research Subject, Research Problem, and Purpose

The subject of research in this paper is ACHP and its complex structure in the context of safety and sustainability.

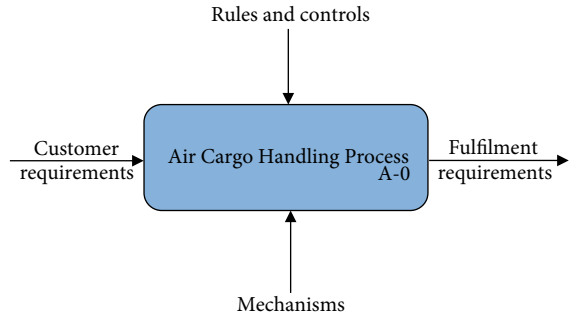

Figure 1: Context diagram of Air Cargo Handling Process.

The problem being researched is the possible impact of the environmental and safety aspects characteristic of particular activities in ACHP on the functionality of the whole process, its profitability and competitiveness.

The purpose of this research is to identify the environmental and safety aspects of ACHP so that process managers at the operational level can identify significant aspects and prevent their possible negative impact on the sustainability of ACHP. It also wants to highlight the need for ACHP to be viewed in context, and to understand context is necessary to understand ACHP sustainability matters and sustainability components. To demonstrate and clarify that to manage ACHP in a way that ensures long-term sustainability, it is necessary to design a model of the functionality of the management system within which ACHP takes place.

In this research, it is a hypothesis that the safety and sustainability of ACHP cannot be achieved without a thorough consideration of the sustainability issues and sustainability components of ACHP, within the framework of a developed model of the functionality of the management system within which ACHP takes place, and that the model should cover the technological aspect of ACHP as well as the management aspect.

3. Background

Business processes can be divided into four types: (1) core business processes, (2) support or logistic processes, (3) management processes, and (4) measurement, analysis, and improvement processes. ACHP belongs to core business processes regardless if the airport itself conducts it or it is managed by a specialized cargo handling organization in the liberalized market conditions.

3.1. Process Definition. The word process originates from the Latin word *processus*, meaning… flow, the way in which something becomes or is, development, procedure… [8]. Process is set of interrelated or interacting activities that use inputs to deliver an intended result [9]. Further on, process means transforming or reshaping input values to output ones, however, not in any way but within the framework of set rules and controls and with application of defined mechanisms, or resources, as shown in Figure 1.

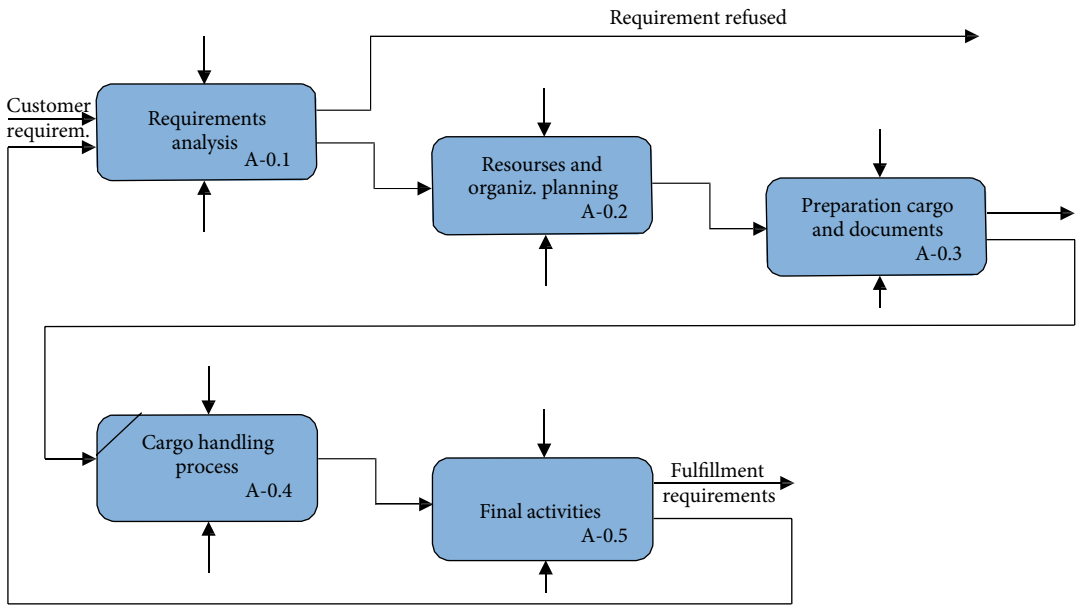

Figure 2: Diagram of Air Cargo Handling Process decomposition.

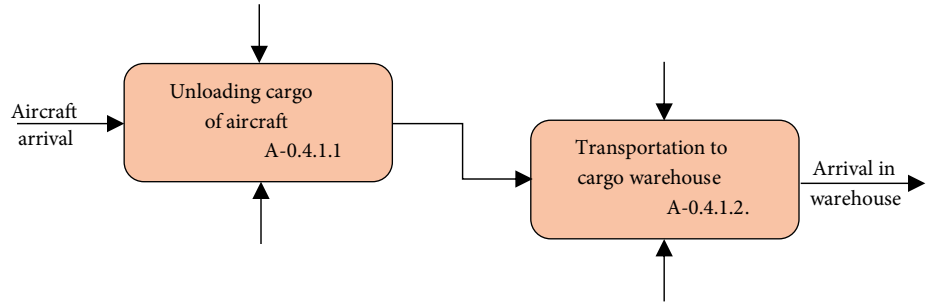

Figure 3: Further decomposition—air cargo handling subprocess (arrivals)—airside.

The process is subjected to some particular rules. Process input is always a requirement of customer/user, regardless in which form it is presented (contract, specification, order, etc.). Process output is a service in case of ACHP with characteristics (quality) that fulfil the customer/user requirements defined at the process input. Rules and controls that must be observed when transforming inputs into outputs can be: international and national standards, laws and other regulations, agreements, specifications, procedures, work instructions, methodologies, etc. Mechanisms or resources needed for process running can be: competent staff, infrastructure, equipment, financial means, work environment, hardware, software, partners, forms, etc.

3.2. Hierarchy of Air Cargo Handling Process. The ACHP is very complex for a number of reasons:

(1) Cargo handling activities at arrival (receipt) and departure (dispatch) run simultaneously, so that this process has two subprocesses: (1) air cargo handling subprocess–arrivals and (2) air cargo handling subprocess–departures;

(2) Physical and documentary handling (receipt and dispatch) activities run simultaneously;

(3) Airside and landside activities run simultaneously;

(4) This process takes place at the same time as two other very specific processes, namely the handling of aircraft and passengers and baggage handling process, too.

In each of the previous processes there is a whole series of so-called critical aircraft handling activities that, in the event of any anomalies in the implementation thereof, may result in aircraft delays.

Drljača [10] concluded that at the same time, the ACHP is a very complex structure, too. Each of the listed subprocesses encompasses several process steps consisting of numerous activities to be carried out to complete all actions within that process step. In this way prerequisites for transition from one process step to the next are created, in such a way that at least one output from the previous process step is also the input to the following process step, as shown in Figures 2–5. It is not possible to start activities in a process step unless all activities within the previous process step have been completed.

The ACHP consists of a series of activities. What these activities are is determined by a written procedure. The procedure is technology. It's know how. Procedures define and describe each activity, according to the sequence of execution. Control points are also defined at which something is measured, evaluated, controlled, or at which it is decided if the activity has been performed in compliance with the requirements or not. If the answer is YES, the process may continue, if the answer is NO, certain activities are repeated until the requested quality level has been achieved. Control points serve to manage the process, so that it does not happen that the final results, in this case the service, does not comply with the user requirements. In such case, it would be too late for any improvement, and only a conclusion could be made that a noncompliant service has been provided, with all consequences such as nonquality costs, loss of reputation, fall of competitiveness, etc. [10].

The procedure clearly establishes responsibility for the realization and control of the realization of each individual activity as each of them is significant or may be problematic from a safety and environment standpoint. Responsibility is determined by the job title.

4. Methodology

In this research some general and specific scientific methods of cognition were applied. Of the general scientific methods of cognition, the system theory method was applied in the part researching the ACHP. A process is a complex structure (system) that consists of process steps or subsystems. Each of the subsystems has a significant impact on the process as a system and when it comes to safety and environmental aspects, too. Furthermore, a modelling method was applied in the research phase in which the ACHP was modelled.

Of the specific scientific methods of cognition in this research, an analytical-synthetic method was applied in the part of the research that relates to the structure of the ACHP and its decomposition into process steps. Also, in the study of safety and environmental aspects characteristic of particular process steps. In this phase of the research, the method of generalization and specialization and the method of induction and deduction were used, too.

5. Results and Discussion

Input to the ACHP is the request of the owner (sender) of the cargo or his agent. The request shall be submitted for the carriage of cargo by air from point A to point B in a safe and timely manner. When fulfilling the user's requirements, care should be taken to ensure that the process is carried out in a safe manner and does not endanger the environment. At the same time, it is required to be profitable for the handling agent, that is, sustainable in every way.

In accordance with the regulations, the shipper of the cargo is responsible for correctly and accurately declaring the type of transport item, adequately and in accordance with the regulations, pack the cargo, inform the logistics operator, and the carrier about the data related to the shipment, distribute information on the nature and stability of the product, and fulfil the obligation to pay fees, and costs in connection with transportation.

The process output should be completion of the air transport service from point A to point B, in accordance with the requirements set by the cargo owner or its agent. Rules and controls for running the process are: international documents regulating air traffic and aircraft cargo transport, customs regulations, security regulations, special regulations for individual cargo types such as for instance the IATA—Dangerous Goods Regulation (DGR) for transport of hazardous substances, cargo handling contracts with aircraft operators, contracts with customers and their agents or forwarders, national laws and regulations, internal quality procedures, work instructions, methodologies, etc. Mechanisms or resources needed for conducting this process can be: competent employees possessing all required licenses for handling certain cargo types or managing special equipment, infrastructure including storage area with all necessary types of special sections (cold chambers, security vaults, storage rooms under temperature regime, area for DGR goods, human remains storage (HUM), live animals storage (Live Animals Regulation—LAR), and special equipment (forklifts, weighing devices, pallets, dollies, thermometers, refrigerators, security screening equipment, etc.) [10].

Figure 2 shows a diagram of ACHP decomposition. Process input is the customer requirement. In the first process step *Requirement analysis (A-0.1)* the customer requirements are analyzed, whether the process is capable to meet these requirements. If the analysis shows that the process is not capable to meet these requirements for any reason, the requirement is rejected, and the customer is officially informed about this. If the requirement can be fulfilled, the next process step *Resources and organization planning (A-0.2)* starts. In this process step resources for carrying out the ACHP in compliance with the customer requirements are planned. The work is organized so that the process can run without setbacks. After all activities in this process step have been completed, it is possible to proceed to the next process step, *Preparation of cargo and documents (A-0.3)*. Preparations for physical handling and documents handling is carried out within this process step. Preparation for physical handling includes preparing necessary Ground Handling Equipment (GSE) units and storage positions for later physical manipulation of the cargo, forming Unit Load Devices (ULD), loading onto dollies and the like. Preparation of documentary handling includes planning of documentation and issuance of documents accompanying the shipment, such as for instance Cargo Manifest, Air Waybill (AWB), Unified Customs Declaration (UCD) and some other documents such as Notification to Captain (NOTOC) accompanying individual types of shipment or cargo (DGR, perishable goods, live animals, etc.). Upon physical and documentary preparation of the cargo, the process step *Cargo handling process* (A-0.4) follows. Air cargo handling is carried out in this process step, meaning physical and documentary handling, running simultaneously on the airside and landside. This process step is therefore complex and needs to be further decomposed (marked with a slanted line in the upper left corner of the graph in Figure 2) [10].

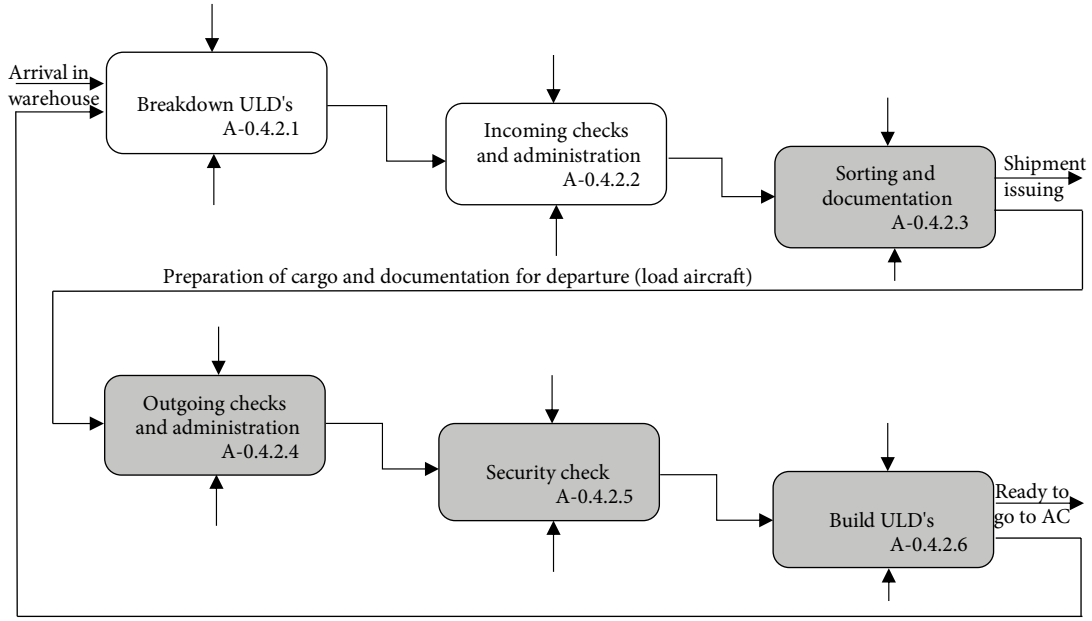

Figure 4: Further decomposition—cargo handling subprocess—(arrivals-departures)—landside.

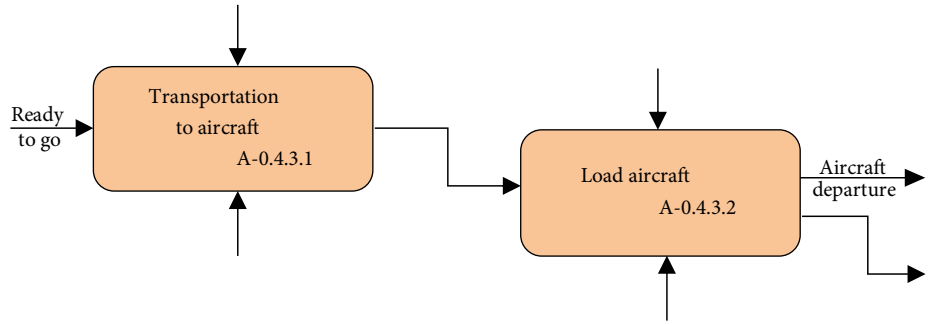

Figure 5: Further decomposition—air cargo handling subprocess (departures)—airside.

5.1. Air Cargo Handling Subprocess (Arrivals)—Airside. *Unloading cargo of aircraft (A-0.4.1.1)* is performed after the arrival of the aircraft on the airside. In order to better prepare the process itself, each airport receives accurate information on cargo loaded at aircraft potential DGR, special goods and other specifics at the moment of departure of the aircraft from the departure point via SITA Load message (LDM), all with the aim of timely and quality preparation for unloading cargo on landing. The shipments themselves can be in containers, pallets, bags, cages or individually, unloaded on dollies next to the aircraft.

After unloading of all consignments with equipment such as a high-loader or conveyor belts and loaded onto dollies, and when supporting documentation has been taken from the aircraft crew, the cargo is transported to the cargo warehouse by a special tractor. Transport takes place on the basis of appropriate procedures. Transport enters the cargo warehouse, what means landside. That is second process step *Transportation to cargo warehouse A-0.4.1.2*.

5.2. Air Cargo Handling Subprocess (Arrivals-Departures)—Landside. Handling (arrivals) and handling (departures) take place at the cargo warehouse and at the freight forwarder on the landside. After the cargo has been unloaded from the aircraft and transported to the cargo warehouse, activities are performed as part of the *Breakdown ULD's process step (A-0.4.2.1)*. By looking at the documentation and messages determines which cargo shipments at this airport complete the journey.

After all activities within the first process step have been completed, the execution of activities within the second process step *Incoming checks and administration (A-0.4.2.2)* can continue. As part of this process step, inbound control of incoming shipments is made, that is, compliance with supporting documentation. It is also determined whether there is damage to the consignments, packaging, etc. If any irregularities are found, a record of defective goods (complaint) is made.

Sorting and documentation (A-0.4.2.3) can continue. What is very important from the point of view of safety and quality, in this process step, activities related to arrivals and departures take place simultaneously. Cargo shipments that end the journey at that airport after entry control and necessary administration will be issued to customers or their agents. They do not

need to be stored because they only pass through the warehouse.

At the same time, the same process participants, the same warehouse and the same agents sort and prepare the documentation related to departure. Preparatory activities are carried out in the fifth process step which is *Outgoing checks and administration (A-0.4.2.4)*. Cargo consignments are checked against the supporting documentation, determining possible damage and whether all the necessary documentation accompanying the consignments has been submitted. Where necessary in accordance with regulations, customs formalities shall be carried out.

Security check (A-0.4.2.5) is the next process step that is approached. Cargo shipments are subject to security controls in accordance with international and national regulations and procedures, as well as airport procedures, depending on the risk assessment. After all activities within the fifth process step have been completed the execution of activities within the sixth process step *Build ULD's (A-0.4.2.6)* can continue. This is a process step in which pallets or containers are formed, weighed, loaded onto dollies, to prepare the cargo for transport to the aircraft. The process flow described is shown in Figure 4.

5.3. Air Cargo Handling Subprocess (Departure)—Airside. Once the transport has been prepared, activities are carried out as part of the *Transportation to aircraft (A-0.4.3.1)* process step, as shown in the Figure 5. As in arrival, transportation is done according to a special procedure. This process step depends on the synergy of cargo warehouse and aircraft Weight and Balance offices. Prior to the start of loading, and on the basis of the documentation obtained from the cargo warehouse, the Load Control Officer develop a Specific aircraft type Load Plan in such a way that they accurately define the loading position of each consignment in terms of location in certain sections of the Aircraft cargo holding bay ensuring that the actual weight of the aircraft does not exceed the maximum structural weight of the aircraft (e.g. Maximum Take-Off Weight, Maximum Zero Weight or Maximum Landing Weight)…, and to secure that aircraft Centre of Gravity, its balance should be within its limits. The *Load of aircraft (A-0.4.3.2)* process step means loading of cargo into the aircraft and is also done according to a special procedure. The loading is monitored all the time by the service controller. After loading, documentation accompanying the cargo is handed over to the aircraft crew.

Upon completion of this process step, prerequisites were created for accessing the final process step (Figure 2) *Final activities (A-0.5)*. This process step includes the activities of distribution of documentation, drafting of reports, communication among process participants, records, billing for the performed service, etc. Exit from the process is an air cargo handling service that, by its characteristics or quality, fulfils the requirements of customer, which are received as process input.

5.4. Types of Air Cargo. There is prejudice and it is usually considered that aircrafts carry more valuable goods that suffer the cost of transport. This is because it is common for the price of air transport to be generally higher than for other modes of transport. In principle, this is generally true, however, worldwide practice shows that aircraft carry almost all types of cargo. Due to different circumstances and exceptional situations such as delivery times, penalties, urgency or other contractual obligations, the goods are transported by air and would be transported in other "normal" circumstances by other means (truck, ship, rail).

This fact is especially important from the point of view of safety and environmental aspects since different types of cargo entail different technologies and practices and entails different types of risks that need to be taken into account.

Appropriate documentation accompanies each air cargo shipment. For all types of shipments and each piece of cargo, documents such as Cargo Manifest and AWB are documents accompanying each type of shipment. These are standardized, unique patterns that are valid worldwide. They contain the necessary information about the shipment and other information needed by the participants, such as information about the starting point and destination of the cargo shipment, etc.

Beside the Cargo Manifest and AWB, other documents can be issued if needed, to accompany a shipment: Mail Manifest (for mail), UCD, Record on Defective Cargo, NOTOC (Special Load), ULD, DGR Checklist, Live Animals Acceptance Checklist, Request for sanitary examination of imported shipment, etc.

Each of these documents contains information on the specific types of cargo shipments, given their specificities. These specifics are of the utmost importance from the standpoint of safety and environmental aspects and should certainly be considered, especially in the risk assessment.

5.5. Safety and Sustainable Aspects of Air Cargo Handling Process. Olapiriyakul et al. [11] concluded to resolve this issue, environmental justice must be added as one of the strategic goals to be achieved. Nocera and Cavallaro [12] said that as the main cause of global warming, CO_2 emissions are a relevant externality in the transport sector.

Vidović et al. [13] reveal that other environmental aspects, such as noise, have a significant negative impact on the sustainability of the process. Most of the researchers are focusing on the influence of air traffic noise and its negative aspect on human health and the environment. Some of the researchers are oriented toward operative measures to reduce the negative effects of noise. Ozkurt et al. [14] analyzed noise impacts of Izmir Adnan Menderes Airport on public health. Research showed that the number of people who are potentially exposed to high noise levels and threatened by several illnesses, such as hypertension and sleep disturbances, is significant in the surrounding area of the airport.

All the safety regulations in civil aviation were published by the European Aviation Safety Agency (EASA) and they are applicable in European airspace. These regulations are at the same time as handling procedures. The two most important (EU) Regulations are EC/76/2014 [15] and Commission Implementing Regulation (EU) 2015/1018 [16], where the second one defines risky events that can happen during all activities related to air civic aviation. Regulation 2015/1018 defines events, which are used in safety reporting systems like Safety Management System (SMS) for easier classification of reported events.

Table 1: Safety and sustainable aspects of cargo handling process.

Handling process step	Safety aspects (S)	Environmental aspects (E)
A-0.1 Requirements analysis	(1) Incomplete and incorrect information from the consignor about the cargo and storage specifics (2) The need for staff to send cargo to check that it can be carried by air (3) The load on the submitted documents has the wrong mass and number of pieces (4) The cargo is not properly marked and packaged	(1) Space utilization (2) Energy utilization (3) Production of waste (4) Radiant energy (heat, light)
A-0.2 Resources and organization planning	(1) Inadequate infrastructure and surface of cargo storage (2) The security equipment (RTG) and its dimensions for checking the cargo in the warehouse are inadequate and do not meet national and international standards (3) Lack of education for RTG cargo screening staff (risk) (4) Insufficient number of personnel for cargo handling in accordance with the type of aircraft (overload of existing staff)	(1) Space utilization (2) Energy utilization (3) Production of waste (4) Radiant energy (heat, light)
A-0.3 Preparation cargo and documents	(1) Lack of staff training to complete the documents (2) Errors in the entry of weight and quantity of cargo on documents (3) Unfamiliarity with the ground handling process (delay in distribution of documents) (4) Ignorance of the functionality of aircraft ground handling equipment and consignment consolidation units to be used for cargo transportation (ULD, pallets, igloo) (5) Potential injury to warehouse employees	(1) Space utilization (2) Energy utilization (3) Production of waste (4) Radiant energy (heat, light) (5) Air emissions (6) Discharge into water (7) Discharge into the soil
A-0.4 Cargo handling process		
A-0.4.1.1 Unloading cargo of aircraft	(1) Collision of aircraft ground handling and other equipment with aircraft on the apron (2) Health hazard of Auxiliary Power Unit (APU) noise (in case of neglect of wearing protective hearing equipment) (3) Leakage of fuel or any liquid from the handling equipment of the aircraft or the aircraft itself (4) Injury/mortality of employees during unloading of cargo from aircraft Heavy Cargo (HEA), Dry Ice (ICE, ...) (5) The packaging of the cargo is damaged, and its contents directly affect the personnel and the equipment unloading it (poison, flammable liquids) (6) Incoming airport does not have adequate ground handling equipment to accept cargo on arrival (improvised equipment is used) (7) Containment and neglect of dangerous and special cargo on the aircraft stand during high temperatures (8) Cargo is left in front of the aircraft unattended (possible theft or uncontrolled movement) (9) Robbery of valuable cargo unloaded from an aircraft (e.g. VAL shipment)—airside	(1) Space utilization (2) Energy utilization (3) Production of waste (4) Radiant energy (heat, light, vibration) (5) Air emissions
A-0.4.1.2 Transportation in the cargo warehouse	(1) In case of insufficient cargo securing, potential drop of cargo on the parking lot or service road from the dollies during transport to the warehouse (2) Safety risk and destruction of cargo value if not adequately covered on dollies under various adverse meteorological conditions (3) Collision of equipment transporting cargo towards the warehouse with other equipment, aircraft or infrastructure	(1) Energy utilization (2) Production of waste (3) Radiant energy (heat, light, noise, vibration) (4) Air emissions

Table 1: Continued.

Handling process step	Safety aspects (S)	Environmental aspects (E)
A-0.4.2.1 Breakdown ULD's	(1) Injury to employees when opening the ULD (unless the load is well stacked) (2) Potential leakage or spillage of content from the ULD can compromise its manipulation (3) Improper use of equipment may damage the ULD	(1) Space utilization (2) Energy utilization (3) Production of waste (4) Radiant energy (heat, light, noise) (5) Air emissions
A-0.4.2.2 Incoming checks and administration	(1) Simplified checks can lead to major security glitches (2) Possible overlook due to inadequate knowledge of standards and recommended practice in cargo handling	(1) Space utilization (2) Energy utilization (3) Production of waste (4) Radiant energy (heat, light, radiation) (5) Air emissions
A-0.4.2.3 Sorting and documentation	(1) Inadequate storage of cargo (2) Inadequate equipment for cargo palatalization (improvisation) (3) Inadequate documentation	(1) Space utilization (2) Energy utilization (3) Production of waste (4) Radiant energy (heat, light, noise, vibration) (5) Air emissions
A-0.4.2.4 Outgoing checks and administration	(1) Simplified checks of documentation and packing of cargo before being taken on board an aircraft (2) Inadequate documentation	(1) Space utilization (2) Energy utilization (3) Production of waste (4) Radiant energy (heat, light, radiation) (5) Air emissions
A-0.4.2.5 Security check	(1) Use of inadequate RTG equipment to protect cargo inspection when entering the airside zone (2) Determination of the type of cargo which may not be carried by air (large quantities of radioactive material)	(1) Space utilization (2) Energy utilization (3) Production of waste (4) Radiant energy (heat, light, radiation) (5) Air emissions
A-0.4.2.6 Build ULD's	(1) Use of inadequate equipment when loading cargo into ULDs (2) Use of defective ULDs (3) Setting up ULD cards with wrong cargo information (4) Improper binding of cargo to/in ULDs	(1) Space utilization (2) Energy utilization (3) Production of waste (4) Radiant energy (heat, light, noise) (5) Air emissions
A-0.4.3.1 Transportation to aircraft	(1) Transporting ULDs on dollies that are not specialized for ULDs (2) The possibility of dropping cargo along the service road and the apron during transportation from warehouse to aircraft (3) Potential damage to cargo due to transport from warehouse to aircraft	(1) Energy utilization (2) Radiant energy (heat, light, noise, vibration) (3) Air emissions

Table 1: Continued.

Handling process step	Safety aspects (S)	Environmental aspects (E)
A-0.4.3.2 Load aircraft	(1) Wrongly planned aircraft load plan based on incorrectly supplied data from the warehouse (2) Use of inadequate aircraft ground handling equipment in accordance with cargo specifics (3) Use of faulty equipment (4) Lack of training of personnel operating the airport equipment (5) Inadequate mooring of cargo or ULD on board (possible change of the Centre of Gravity during all phases of flight	(1) Space utilization (2) Energy utilization (3) Production of waste (4) Radiant energy (heat, light, noise, vibration) (5) Air emissions
A-0.5 Final activities	(1) Failure to inform the aircraft captain of the dangerous or special cargo loaded (2) Unsigned documents by all participants in the process (3) Neglect to send a SITA LDM message to the destination airport	(1) Space utilization (2) Energy utilization (3) Production of waste (4) Radiant energy (heat, light) (5) Air emissions (6) Discharge into water (7) Discharge into the soil

Table 2: The importance of Air Cargo Handling Process sustainability components.

Components	Component elements	Importance	
Safety	(1) Safety cargo handling staff (2) Safety customers (3) Safety freight forwarders (4) Safety other process partners (5) Safety aircraft (6) Safety cargo (7) Safety infrastructure (8) Safety Air Cargo Handling Process (9) Safety airport operations	(1) Customer confidence (2) Partner confidence (3) process competence (4) market position	Competitiveness
Environment	(1) Environmental management system (2) Green airport project (3) Environmental costs	(1) Society confidence (2) Customer confidence (3) Partners confidence (4) Cost optimization	Competitiveness
Quality	(1) Customer focus (2) Interested parties requirements (3) Quality principles (4) Quality costs (5) Business excellence	(1) Customer satisfaction (2) Interested parties satisfaction (3) Integrated management system (4) Cost optimization (5) Continuous improvement (6) Market position	Competitiveness

A Ground Handling organization determines its safety and environmental aspects and associated environmental impacts and determines if they significant and, therefore, need to be addressed by its SMS and Environmental Management Systems (EMS) as a part of handling organizations' Integrated Management System (IMS). Each activity within the ACHP has its own safety and environmental aspects. Each of the safety and environmental aspects shown in Table 1 can have a significant impact on the functionality and quality of the process and the final result of the process, which is manifested in the air cargo handling service performed. This actually means that the safety or environmental aspect of any activity can endanger the whole process and its sustainability.

Change to the environment, either adverse or beneficial, that result wholly or partially from environmental aspects are called environmental impacts. The environmental impact can occur at local regional and global scales and also can be direct, indirect or cumulative by nature. The relationship between environmental aspects and environmental impacts is one of cause and effect [17].

These environmental and safety aspects are due to the operational providing of the technology, namely ACHP. By applying a specific methodology applied within the framework of the ISO 9001: 2015 quality management system and the ISO 14001: 2015 environmental management system, the organization has identified significant environmental and safety aspects. Specific management plans are developed for them to reduce their negative environmental and the safety impact of ACHP operations. This is often a lengthy process and requires investment in new equipment, employee training, implementation of new IT solutions, and more. The goal is for ACHP to operate in a manner that minimizes the environmental impact and ensures the maximum level of process safety. If no improvements were made in this segment, ACHP would have a significant negative environmental impact, causing significant environmental costs in the long run and making the process unprofitable. Likewise, insufficient safety of process employees and customer (commodity) assets would make ACHP uncompetitive and unprofitable, causing significant costs due to (non) quality (complaints, litigation, etc.), and ultimately endangering the survival of the cargo handling agent on the market. Therefore, it is essential to properly review and evaluate the safety and sustainability aspects of ACHP in order to identify significant aspects and to manage them in a way that contributes to the functionality and thus competitiveness of ACHP. To maintain the functionality of the system, it is necessary to design a model of the functionality of the management system within which ACHP takes place (Figure 6).

Business processes are part of an organization's management system. In the Handling Agent case shown, ACHP is the core business process. Input into the process are requests from stakeholders (users, owners, immediate and wider community, partners, and employees). During the process, environmental and safety aspects need to be considered, as they have a significant impact on the output of the process and the level of stakeholder satisfaction. Risk management enables the identification of significant environmental and safety aspects and their impact on ACHP and the functionality of the handling organization's entire management system. The result of the process is an ACH service that fulfills the requirements of the stakeholders defined and recognized as the input of the process. The management system within which the process takes place is based on: leadership, planning, and logistical support for the realization of ACHP, operations whose output needs to be verified. Verification is performed to determine if the customer requirements and other interested parties have been met. Following an evaluation that identifies areas for improvement, an improvement plan is implemented in the next process cycle. The system operates in continuous cycles, on the

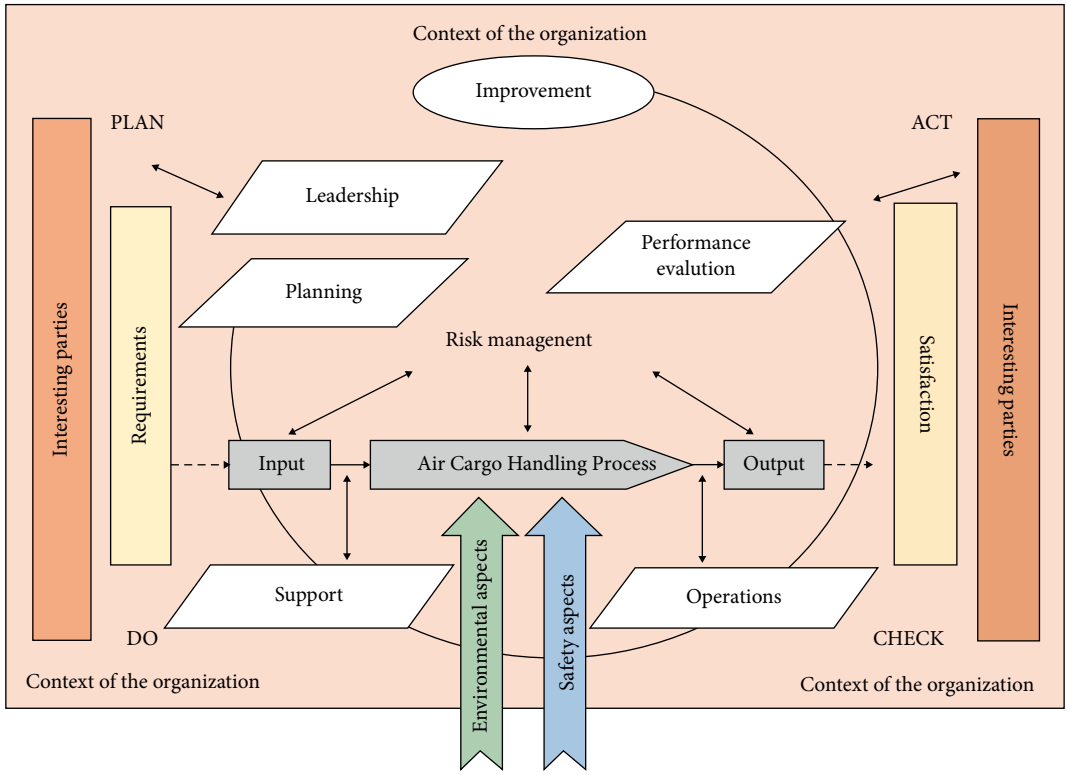

Figure 6: A model of the functionality of the management system within which ACHP takes place.

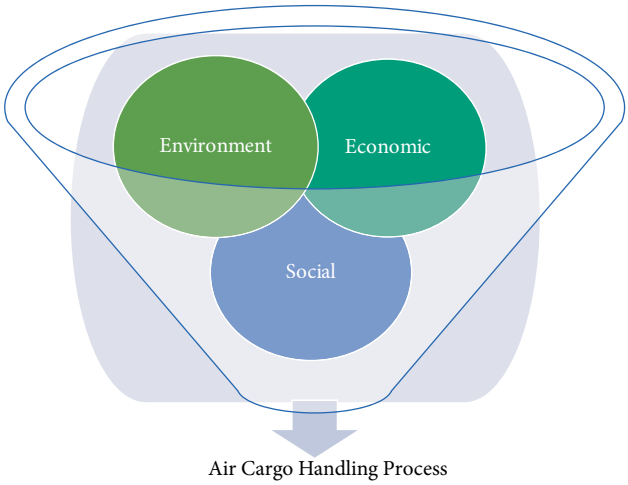

Figure 7: Air Cargo Handling Process sustainability matters.

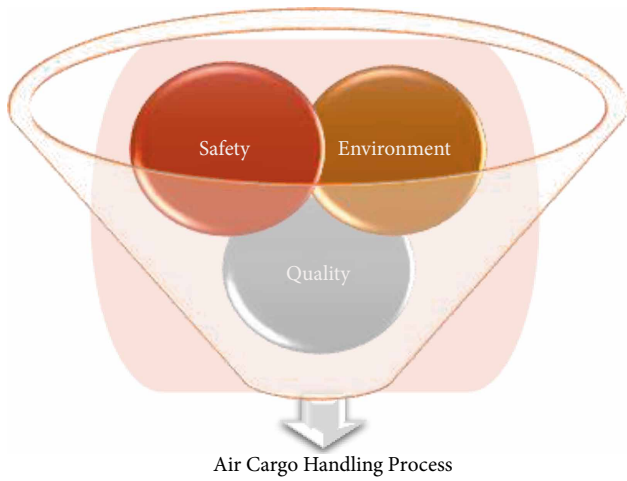

Figure 8: Air Cargo Handling Process sustainability components.

principle of P-lan, D-o, C-heck, A-ct, known as the Deming circuit [18]. The system of handling organization should be viewed in context, in order to get a realistic point of view. Management involves understanding the context.

The value of applying the model shown in Figure 6 is in presenting and understanding the model of the functionality of the management system under which ACHP takes place, with a focus on the specification of environmental and safety aspects that affect ACHP and significantly affect the quality of process results. Without specifying the environmental and safety aspects and without understanding the model of functionality of the ACHP management system, it is not possible to improve the quality of service, which weakens the competitive ability of the handling agent. This approach indicates the direction of action in terms of risk identification and prevention, and an understanding of the environmental and safety aspects of ACHP. Likewise, the model integrates the technological aspect and the management aspect of the context in which ACHP takes place.

Each of the safety and environmental aspects, at any process step, contributes to the quality of the results of the whole process, but can also jeopardize it. The safety and environmental aspects and the description of their meaning are shown in Table 1.

The development of long-term strategies and investments to achieve a sustainable industry is a key to guaranteeing the future of air cargo. IATA is working on several cargo sustainability initiatives tackling environmental, social, and economic matters [3]. Figure 7 shows how those sustainability meters produce a synergistically positive effect on the process.

Drljača and Sesar [19] analysed that the process can take place even if some of the aspects are on the important level, but then the result of the process will not be at the highest level of safety. This circumstance could affect the cost of the service and the emergence of nonquality costs, and competitiveness of cargo handling organization, the process will not be high level safety and sustainable and in extreme cases the market position can be problematic.

Safety and environmental aspects of ACHP can be displayed in the following way:

$$SA0n = Sfn_1 + Sfn_2 + \ldots + Sfn_5, \quad (1)$$

where symbols have the following meaning:

$SA0n$—the safety aspects of a process steps A-0.1 to A-0.5.

$Sfn1$—particular safety aspect from process steps 1–5.

The safety aspects of the ACHP can ultimately be presented in the following way:

$$ST = SA0.1 + SA0.2 + \ldots + SA0.5, \quad (2)$$

or:

$$ST = \sum_{n=1}^{5} SA0n, \quad (3)$$

where symbols have the following meaning:

ST = the overall safety of the ACHP.

$SA0.1, 2,\ldots, 5$ = the safety of a particular process step in the ACHP, from 1 to 5.

Related with the environmental aspects of ACHP:

$$EA0n = Efn_1 + Efn_2 + \ldots + Efn_5, \quad (4)$$

where symbols have the following meaning:

$EA0n$ – the environmental aspects of a process steps A-0.1 to A-0.5

Efn_1 – particular environmental aspect from process steps 1–5.

The environmental aspects of the ACHP can ultimately be presented in the following way:

$$ET = EA0.1 + EA0.2 + \ldots + EA0.5, \quad (5)$$

or:

$$ET = \sum_{n=1}^{5} EA0n, \quad (6)$$

where symbols have the following meaning:

ET = the overall sustainability of the ACHP.

$EA0.1, 2,\ldots, 5$ = the sustainability of a particular process step in the ACHP, from 1 to 5.

For the sustainability of the ACHP, as explained above, the environment, economic, and social components must be considered (Figure 7). This is because sustainability is a complex phenomenon. In addition, these three components are in constant and intense interaction and affect each other in all directions.

At airports, when it comes to core processes and ACHP being one of them, one cannot speak of quality unless it also implies safety (Formula (7)). The environmental component is also indispensable, because most often in addition to quality and safety, it is an important and frequent part of an IMS at the airport or special cargo handling organization. Regardless of the level of management's knowledge, all management systems are integrated to a greater or lesser extent, regardless of whether they are certified by independent certification bodies. For airports and handling agents, the integration of quality management, environmental management and safety management systems is common.

$$PS = Sc + Ec + Qc, \quad (7)$$

where symbols have the following meaning:

PS = ACHP sustainability,

Sc = safety components,

Ec = environment components,

Qc = quality components.

Each of these three components has a number of elements to consider (Figure 8). It is also necessary to understand their importance for the entire ACHP (Table 2).

The ultimate goal of the complex ACHP research whose results are presented in this paper is the need for the process to be competitive. In fact, the degree of its competitiveness in today's global market conditions is a condition of its survival. Airlines and cargo shipment owners have the ability to choose cargo handling agents at the vast majority of airports in the world. Therefore, the degree of competitiveness of this process is crucial for every air cargo handling agent and greatly influences the accomplishment of its mission and its survival in the market.

6. Conclusion

ACHP is a complex process. This is because both activities take place at the same time: on arrival and departure, on the airside and on the landside, physical ground handling and documentary handling, too. Further, this process takes place at the same time as two other very specific processes, namely the handling of aircraft and passengers and baggage handling process, too. This process is part of the process structure of the organizations that manage it, which consists of: management processes, core business processes, support processes and measurement, analyst, and improvement processes. It is a core business process for more airports and for each special air cargo handling organization, too. The goal is to meet customer requirements, which means that the goal is quality of service as a result of the process. But at airports there is no quality without safety. Another important component in terms of sustainability is the environment. For this reason, when it comes to ACHP, it is necessary to consider the safety and environmental aspects of the process, as well as the elements of all three of its components: safety component, environment component, and quality component as an IMS. This approach creates the preconditions for continuous improvement and increasing the degree of competitiveness of the process. This

is because today there is competition from airports and cargo handling companies, and the selection criterion is first and foremost quality. In these circumstances, the task of ACHP management is to achieve a level of management that guarantees process reliability and customer satisfaction. This is a prerequisite for competitiveness. The safety and sustainable ACHP can be established if a system for managing the impacts of individual safety aspects and environmental aspects is established and it manages each element of safety, environment, and quality components. In these circumstances, it is possible to achieve the synergy of economic, environmental, and social factors necessary to ensure the safety and sustainability of ACHP in the long run. This research identifies the environmental and safety aspects of ACHP, enabling process managers at the operational level to identify significant aspects and prevent their possible negative impact on the sustainability of ACHP. The results of the research show that there is a significant impact of the environmental and safety aspects specific to particular activities in ACHP and that they affect the reliability and functionality of the whole process, its profitability and competitiveness. This points to the need for ACHP to be viewed in context, and to understand context it is necessary to understand ACHP sustainability matters and sustainability components. It has also been shown that to manage ACHP in a sustainable way, it is necessary to design a model of the functionality of the management system within which ACHP takes place. Further research should be conducted towards refining the methodology for identifying significant safety and environmental aspects, as these will change as circumstances change, such as changes in the legislative and technological framework governing safety and environmental issues. The research results confirm the hypothesis that safety and sustainability of ACHP cannot be achieved unless they are thoroughly considered sustainability matters and sustainability components of ACHP, within the developed model of the functionality of the management system within which ACHP takes place and that the model should cover the technological aspect of ACHP as well as the management aspect. Further research should also be directed towards the cost component of ACHP development, as it is expected that the charge of providing services will be cost-based and that ACHP will not generate a loss. This is because the management of significant aspects and sustainability components entails financial investment, both in new technologies and in human resources competency.

Data Availability

The data used to support the findings of this paper are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding the publication of this paper.

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