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BACHELOR THESIS
(EXPLANATORY NOTE)

Theme: «Organization of cargo handling at cargo terminal of Boryspil airport»

Done by: Ihor A. Tishyn

Supervisor: Iryna I. Vysotska, PhD in Economics, Associate professor

Standards Inspector: Yuliia V. Shevchenko, PhD in Economics, Associate professor

Kyiv 2021

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ

НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

Кафедра організації авіаційних перевезень

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач кафедри
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ДИПЛОМНА РОБОТА
(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ «БАКАЛАВР»

Тема: "Організація обробки вантажів на вантажному терміналі аеропорту Бориспіль"

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NATIONAL AVIATION UNIVERSITY

Faculty of Transport Management and Logistics

Air Transportation Management Department

Major (specialty): 275 "Air Transportation Technology"

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"_____" _____2021

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TASK

of completion the bachelor thesis

Tishyn Ihor

1. Theme of the bachelor thesis entitled «Organization of cargo handling at cargo terminal of Boryspil airport» was approved by a decree of the rector order № 668/st. from 27.04.2021.

2. Term performance of thesis: from 04.05.2021 to 16.06.2021.

3. Initial data required for writing the bachelor thesis: Scientific articles, Accounting reports of Boryspil International Airport, Accounting reports of State Aviation Service of Ukraine, Accounting reports of Government statistics, Accounting reportы of State Customs Service, website of Boryspil International airport, other internet resources.

4. Content of the explanatory notes: abbreviations, content, introduction, analytical part (general characteristics of Boryspil cargo terminal, research of cargo handling process), design part (evaluation effectivity of terminal operation, substantiation dimensions of warehouses and number of mechanized means, reveal malfunctions

during operational process, determine perspectives of cargo terminal development and ways of it's utilization).

5. List of mandatory graphic matters: accommodation of runways at the Boryspil airport, range of services offered by cargo terminal, functions of the cargo terminal, comparative analysis of cargo turnover of different airport during various periods, forecasting of cargo turnover using trend line method.

6. PLANNING CALENDAR

№	Assignment	Deadline for completion	Mark on completion
1	Collection and processing of statistical data	04.05.2021	Done
2	Writing of the theoretical part	14.05.2021	Done
3	Writing of the analytical part	25.05.2021	Done
4	Writing of the design part	31.05.2021	Done
5	Writing of the introduction and summary	04.06.2021	Done
6	Execution of the explanatory note, graphic matters and the presentation	10.06.2021	Done

7. Given date of the task: April 27, 2021.

Supervisor of the master thesis: Iryna I. Vysotska

Task was accepted for completion: Ihor A.Tishyn

EXPLANATORY NOTE

Explanatory note to the bachelor thesis «Organization of cargo handling at cargo terminal of Boryspil airport»**:** 72 pages, 22 figures, 9 tables, 29 formulas, 22 references.

KEYWORDS: AIRPORT, CARGO TERMINAL, FREIGHT, WAREHOUSE, STATISTICS, OPTIMIZATION, CARGO HANDLING, CARGO TURNOVER

Object of the bachelor thesis is cargo terminal of Boryspil airport

Subject of the bachelor thesis is research of cargo terminal functioning, reveal malfunctions, elaboration methods for increase of productivity.

Main task of the bachelor thesis is analysis of current production indicators and implementation of ways of productivity increase.

Methods of analysis include statistics overview, critical thinking, mathematical formulas, forecast by trend line method and ABC XYZ analysis.

The relevance of the thesis based on increase efficiency of the enterprise, increasing the volume of transportation and increase airport revenues.

ABREVIATIONS

ICAO – International Civil Aviation Organization

SE – state enterprise

DAL – domestic airline

IAL – international airline

IATA – International Air Transport Association

ATC – Air Traffic Control

SGHA - Standard Ground Handling Agreement

DGR – Dangerous Goods Regulations

LAR – Live Animals Regulations

MAWB – Master Air Waybill

HAWB – House Air Waybill

CONTENT

INTRODUCTION

International airport it is air gate of the country and important element of supply chain. Airport has influence for cargo safety during handling and storage, duration of cargo pick up at cargo terminal, fees for provided services. All this indicators can be determined by airport structure like: runways, taxiways, warehouses, number of mechanized means and their variety, premises for cargo consolidation, screening using X-Ray machines, quality of employees job performing and level of interaction between different structural departments within terminal, e.g. interaction among customs, airport, airline and forwarder's department. Each structural department must definitely know zone of it's responsibility carry out own duty in appropriate way. This way of functioning allows to set responsibilities and permissions for each, which reduces time for job performing and claim procedures. Thus optimal functioning of cargo terminal can be achieved by continuous work of many departments in a single unit.

Another thing which determines success of cargo terminal it is capacity which follows from designing calculations based on predicted flows. Design of terminal involves linear dimensions of warehouses for each type of cargo, number of stacks and cells, length and width of runways and taxiways, number of different mechanized vehicles, square of parking place for trucks before warehouse, dimensions of doors of warehouses and it's quantity. Very important role play ability to forecast cargo flow for preparation of operational zones or for planning of reconstruction of terminal.

ANALYTICAL PART

1.1 General information about Boryspil cargo terminal

Boryspil International airport located about 29 km from Kyiv. It is the biggest airport in Ukraine, having both passenger and cargo terminals. This terminals serve international and intercontinental flights. IATA code is KBP, ICAO – UKBB. Due to technical abilities, the airport can accommodate arriving and departing aircraft during bad weather conditions e.g. fog, rain, snow, dust, smoke, in general, everything that lowers visibility, but in tolerance. KBP is a member of Airport Council International, Air Transport Association and International Civil Aviation Organization.

Boryspil is successfully located at the intersection of many air routes connecting Asia with Europe and America. More than 40 national and foreign airlines like: Ukrainian International Airlines, Windrose, Azur Air Ukraine, Turkish Airlines, Flydubai, KLM, Air France, Lufthansa, Austrian Airlines AG, Czech Airlines, LOT Polish Airlines, Yanair, Cyprus Airways, Swiss International Airlines AG, Ryanair, Laudamotion, EL AL Israel Airlines, Qatar Airways, Belavia, Air Baltic, Air Arabia, Air Astana, Georgian Airways, SkyUp, Aircompany Jonika LLC, Bravo Airways, carry out passenger and cargo transportation from Boryspil on 77 regular routes around the world.

The airport has 2 runways. Where runway № 1, it's code 18L/36R (see Fig. 1.1) at Boryspil airport was completely renovated and extended to 4 km in 2001 with funds from the European Bank for Reconstruction and Development. Taxiways, aircraft stands and Terminal D (see Fig. 1.2), which has been the main passenger service at the airport since 2013, have been built near the runway. Its length of 4,000 meters and a width of 60 meters can accommodate aircraft of all types around the clock, including in conditions of limited inspection during bad weather and ice. Taxiways are often called taxi strips and designed to provide movement of aircraft without dangerous through airfield. Taxiways ensure direct access between terminal and runway. Due to high traffic taxiways go parallel to the runways increasing airport capacity.

Aircraft stands provide places for aircraft parking where loading and unloading can be completed.

Fig. 1.1 Runway №1 to the left side of the picture

Huge numbers in the range from 1 to 36, located on both sides of the strip, and which never coincide with each other. This is not the serial number of the airport or the strip itself, as one might think at first glance. Lines with the same number designations exist in different countries around the world. The two-digit numbers that are found on each side of any runway indicate its location relative to the magnetic pole of our planet, or rather, relative to the magnetic course. The magnetic heading is determined by the direction of the magnetic field lines at a given point on the globe. In addition to the numbers at the beginning of the runway, there are always stripes that outwardly resemble a pedestrian zebra. These stripes, or rather their number, measured from the center line, allows the pilot to determine the width of the strip. If the marking consists of 4 lanes, then the runway width is 18 meters, 6 lanes - 23 meters, 8 lanes - 30 meters, and so on. The more the number of lanes, the more opportunities for the pilot to maneuver, for example, in case of landing in adverse weather conditions.

The 2-nd runway, it's code 18R/36L has already worked out its resource and, due to many years of use with a significant load, cannot be renewed. On February

3, the Ukrainian government recognized it expedient to take a loan of 270 million euros for the reconstruction of the air zone № 2 of the Borispol airport. The money is planned to be borrowed from the European Investment Bank. The government approved the dispatch of a delegation to negotiate with a financial institution. In addition to the new runway, taxiways, an emergency rescue station, treatment facilities and sites for treating aircraft from snow and ice in winter and checking engines will be built at the airport.

1.2 Characteristics of cargo terminal

Today, in fact, the only operating cargo air terminal in Ukraine is located in the Boryspil International Airport. Its management, in order to develop this area of activity, intends to stake on the delivery of goods purchased via the Internet. Other experts interviewed agree that east-west transit will be the main vector of cargo delivery by air to Ukraine or through our territory to European countries. However, it is noted that the domestic market must also consume goods delivered by air (see Table 1.1).

Table 1.1.

In order to handle cargo, the terminal posses [1]

Total area of terminal:	14580 (m^2)
Warehouse premises:	9 (quantity)
Total area of warehouses:	5072 (m^2)
Video surveillance system of the territory and warehouses	-
Fire alarm system in warehouses	-
Automated cargo accounting system	-

Special equipment for mechanized cargo handling (container loaders, forklifts with a carrying capacity of 1.5 to 7 tons, container trolleys, trucks with a lifting body, belt conveyors, rockers, tractors)	-
Highly qualified, educated and certified personnel for working with dangerous goods, live animals.	-

Cargo terminal has:

1) Structural subdivisions of Kiev customs (customs post "Boryspil - Airport")

2) Sanitary and quarantine point of the sanitary epidemiological station

3) Ecological control post of ecological safety

4) Plant quarantine point

5) Veterinary point of state control

6) Offices of representative offices (general agents) of airlines and freight forwarding companies.

Where,

1) Structural subdivisions of Kiev customs (customs post "Boryspil - Airport")

The customs post is a customs authority that is part of the customs as a separate structural unit and in the area of its activities ensures the implementation of tasks assigned to the customs service of Ukraine. It ensures:

- Direct implementation of customs affairs, control over observance by all legal entities and individuals of the legislation of Ukraine on customs affairs.

- Application of tariff and non-tariff regulation measures in accordance with the legislation of Ukraine, full and timely collection of taxes, fees (other obligatory

payments) when moving goods and commercial vehicles across the customs border of Ukraine or customs procedures.

- Implementation of customs control and customs clearance of goods and vehicles, humanitarian aid. Taking measures to protect the interests of consumers of goods, preventing the importation into the territory of Ukraine and release for free circulation of low-quality goods, goods that harm the environment and do not meet the standards and requirements in force in Ukraine.

- Creating favorable conditions for accelerating trade, increasing passenger traffic across the customs border of Ukraine and protecting the intellectual property rights of legal entities and individuals in the process of foreign economic activity. Ensuring cooperation with civil society institutions, public participation in the formation and implementation of state policy in the areas of activity.

- Ensuring the application of customs regimes, customs control and customs clearance of goods placed in the relevant customs regimes.

- Promoting the protection of intellectual property rights in the process of foreign economic activity, preventing the movement of counterfeit goods across the customs border of Ukraine.

- Fight against smuggling and violations of customs regulations.

- Issuance of certificates of origin in cases established by international agreements.

2) Sanitary and quarantine point of the sanitary epidemiological station

Sanitary and quarantine control - a type of state sanitary and epidemiological control regarding to people, goods and mechanized means controlled by the state sanitary and epidemiological supervision (control) at points along the border of the State, in interstate transfer railway stations or joint stations in order to preventing the import of hazardous goods for people, the import, emergence and spread of infectious and mass non-infectious diseases (poisoning).

3) Ecological control post of ecological safety

Ecological control is one of the main functions of environmental protection management and ensuring rational use of natural resources. Environmental control

is understood as the activities of authorized entities that verify the implementation of the current environmental legislation and compliance with its norms.

The tasks of environmental control are formulated in Art. 34 of the Law of Ukraine "On Environmental Protection" dated June 25, 1991 No. 1264-XII. They consist in ensuring compliance with the requirements for environment safety by governments and enterprises and organizations, regardless of the form of ownership and subordination, as well as by citizens.

The use and protection of lands, subsoil, surface and underground waters, atmospheric air, forests and other vegetation, fauna, marine environment and natural resources of territorial waters, the continental shelf and the exclusive (sea) economic zone of the republic, natural territories and objects subject to control are subject to control. special protection, the state of the environment.

Environmental control is carried out in the form of preliminary and current control. Preliminary control is carried out in relation to various types of activities that may affect the state of the environment (coordination with environmental protection authorities of projects for the construction of facilities, participation of representatives of these bodies in the work of state acceptance commissions, etc.). Current control is carried out at the stage of operation of facilities that affect the state of the environment, in the process of using natural resources, etc.

Depending on the authorized entity that exercises control functions and the scope of its action, environmental control is subdivided into state, departmental, industrial, public, together they constitute a mechanism for monitoring compliance with environmental legislation in any area of its action.

4) Plant quarantine point

Plant quarantine is a system of state measures aimed at protecting the country's plant resources from importation and at preventing the spread of quarantine objects and other especially dangerous plant pests, established by the relevant authorities of each country.

5) Veterinary point of state control

Veterinary control is the activity of customs authorities aimed for prevention of import and spreading of hazardous disease, which have bad impact for people and animals and goods. To pass customs control, controlled goods must be accompanied by veterinary or phytosanitary certificates, depending on the cargo being transported. These documents are issued by the authorized bodies of the exporting countries, which are designed to control the import / export of goods falling under veterinary or phytosanitary control. A veterinary certificate is a document confirming that the cargo of animal origin (materials, raw materials, food, biological material, fertilized fish roe, live and slaughtered livestock, poultry) is not contaminated, or received from a healthy animal and comes from a non-contaminated area. In addition to the certificate, for the export, import and transit of goods of animal origin, it is necessary to obtain permission from the authorized body for this.

6) Offices of representative offices (general agents) of airlines and freight forwarding companies.

Task of freight forwarding company is to prepare cargo for transportation and deliver it to the aircraft. Also consolidated cargo can be provide with this functions. Freight forwarder provides preparation of cargo, warehouse operations, carriage and delivery, handling of documents and simplification of formalities. Mainly forwarder rarely behave as carrier. Forwarder to carry out transportation of goods by different modes of transport and auxiliary service. This transportation can be conducted by multimodal transport. Mixed transportation is a combination of cargo delivery by air with rail, auto or rail transport [3].

1.3 Services of cargo terminal

The largest cargo terminal in Ukraine located in of Boryspil airport with appropriate equipment. Equipment are located within the territory of cargo terminal, allowing variety of transportation. The annual turnover approximate 40000 kg of cargo.

Cargo terminal has infrastructure which make possible cargo handling in accordance with international standards. Equipment and mechanization allow to process all the main types of cargo transported by air. 100% of the personnel involved in cargo handling are certified for cargo handling in accordance with the requirements of Airside Safety, Aviation Security, Weight & balance and load control, DGR, LAR and are allowed to work on various types of platform equipment.

Cargo and mail are processed around the clock. On the territory of the cargo terminal there is a customs post "Boryspil-airport", a sanitary-quarantine point of the sanitary epidemiological station, a post of ecological control of ecological safety, a point of plant quarantine, a veterinary point of state control, offices of representative offices of airlines and freight forwarding companies (see Table 1.2) [2].

Table 1. 2.

Services provided by Boryspil cargo terminal

Ground handling of general, special cargo and mail on flights with cargo aircraft
Movement of cargo from the aircraft to the warehouse and vice versa, the consolidation and deconsolidation of cargo on cargo and passenger aircraft
Warehouse processing, which includes loading and unloading of trucks and storage of goods in the warehouse.
Processing of accompanying documents for cargo and information support.
Execution of accompanying documents for the transport of dangerous goods in accordance with the requirements of DGR
Accelerated cargo handling
Freight administration
Storage of airline's ULD

1.4 Interaction between cargo terminal and airlines

After the division of impoverished aviation companies into two independent airlines: airport and air transport, the airport becomes a place where the interests of different partners and different types of activities for air transportation meet. The role of the airport is to unite partners and users to create a unique product - air travel. Airport has a wide variety of functions and large funds, as a result it acts as a monopoly on the market of air. Thus, the new status of airport and air transport enterprises and the emergence of simultaneously different forms of ownership of aviation enterprises required the establishment of new organizational foundations for their interaction in air transportation.

The main functions of the airport are reduced to providing ground handling for air transportation by the way this activity for both international and domestic carriage at various levels of the reform was from 20 to 15% of the cost of air transportation. Global data corresponds to the following measurements but, however, following data represents expenses for airline handling, also ground handling provided directly for servicing air transportation ranges from 7 to 9%.

When divided into two organizational structures: the airport and the airline, their interaction remains in the production sphere of ground support and the organization of air transportation, at least in the ground handling of passengers and aircraft. At the same time, the range of services provided can be differentiated with respect to performers. Services, including the use of the aerodrome, air traffic control systems and directly servicing the takeoff and landing of aircraft, operational maintenance of the aircraft, as a rule, relate to the public sector of airport management.

Services, including the use of complexes of the airport's service and technical territory, in particular, the airport terminal, can be attributed to the private sector and are performed by different contractors-partners. Thus, airlines are given the opportunity to choose the most beneficial interaction with the airport, and ultimately, to choose the appropriate contractor. Alternative providers of ground

services for the provision of air transportation can be the personnel of the airport, the airline's own or foreign, as well as agency (handling) companies, controlled and / or subordinate directly to the airport or the airline. Naturally, the use of one or another variant of interaction depends on the working conditions and state of the airline, airport, airline of partners - agency and handling companies.

The set of services that make up the ground handling of air transportation is defined by IATA and is presented in the "Agreement on Ground Handling" - ("Standart Grownd Handling Agreement" IATA SGHA, AHM810, 1998). Performers or providers of various types of ground handling services can be represented by:

- operators airport;

- representatives of airlines;

- independent agency or handling companies.

The concept of an "independent company" is conditional, some foreign companies actually work at airports on the terms of private owners of one or another airport complex, for example, the British handling company "Seriair", a member of the "Industrial Cleaning Group" alliance. Most of the so-called independent companies are operated by airport operators or airline managers on a contractual basis. Thus, the interaction of the airport with airlines is of various forms with a different number of participants performing certain services.

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- the effectiveness of the services provided, including the viability and profitability of the company;

- honesty regarding the rules of competition;

- responsibility for safety and quality assurance.

When characterizing the participants according to these criteria, their main goals should be taken into account. The main goal of the airline's ground handling administration is to provide a better service for its own flights using its own standards. Ultimately, ground handling is not the main business of the airline and it can transfer this business to a third party at fairly low prices, considering this activity as an addition to the main one [4].

For agency and handling companies, ground handling is the main business, therefore, they must effectively develop and improve the quality of services provided, and like any private company in a competitive environment, they must increase their image and competitiveness, bringing the quality of services performed to the standards required by customers. Airport perform following activities during organization of air transportation:

- provision of takeoff and landing operations of aircraft;

- servicing air carriers (crews), passengers (reception, dispatch) and clientele;

- handling (acceptance, dispatch) of baggage, mail and cargo;

- technical and commercial maintenance of the aircraft;

- operation of the aerodrome, air terminal;

- provision of storage and refueling;

- operation of means of providing technical processes in the airport area with heat, electricity, transport and communications, etc.

When an airline is divided into an airport and an airline, the following complex of buildings, structures and equipment is transferred to the airport's disposal:

• buildings and structures of the passenger and cargo complex (terminals);

• airfield - an airfield, a specially equipped land plot with runways, a system of taxiways, apron, aircraft parking areas and special-purpose aircraft maintenance areas;

• ATC and radio navigation landing facilities;

• buildings and structures for aircraft maintenance; • buildings and structures for storage and refueling of fuel and lubricants;

• buildings and structures for the provision of heat, electricity, communications and transport;

• buildings and structures for auxiliary purposes.

After separation aviation enterprises into airline and airport, airport has own equipment and funds, as a result became a monopoly on the market of air transportation (see Table 1.3) [4].

Table 1.3.

Airport functions and production complexes

Airport functions	Production complexes
Handling of cargo and mail	• Cargo terminal • Mechanized means complex • Air transport complex
Aircraft servicing	• Organization of air traffic complex • Commercial and maintenance complex
Flight safety provision	• "State Aviation Service of Ukraine" • Flight safety service
Provision of technological processes	• Service which provides lightning, water, electricity.
Provision of airport effectivity and development of production activity.	• Rental and leasing services

Search and rescue services	• Search and rescue department
Utilization and building of premises etc	• Building department
Establishment of agreements with partners	• Management department
Provision of surveillance for environment and keeping general rules for ecology	• Ecology and environmental safety departments
Employee qualification development	• Human resource department

Based on the above, we can single out the main indicators of the airport and the airline. For example, for an airline such indicators are:

- The number of flights performed with distribution to domestic and international, passenger and cargo;

- The volume of transportation of passengers, cargo and mail with distribution to domestic and international;

- The structure of flights performed and the volume of traffic by regions and directions, etc.

For the airport, the main volume indicators of activity are:

- The number of flights served with a distribution to domestic and international;

- The volume of departures, arrivals and transit of passengers, cargo and mail through the airport with distribution to domestic and international departures;

- The number of airlines served at the airport, etc.

1.5 Operational procedure for import and export

To receive the cargo at the cargo terminal of Boryspil airport, the recipient must enter the territory of the cargo terminal. To enter the territory of the Boryspil cargo terminal, you need to issue a pass at the checkpoint. To do this, you need a

passport for the car and an air waybill number or another document that contains the name of the consignee / sender of the cargo. Then you enter and go to the entrance to the territory of customs and warehouses to the barrier.

When registering for import, it will be possible to call in only after the air cargo has been cleared and the air waybill has been provided with a customs mark on the release of the cargo for free circulation. For customs clearance of imports, you need to obtain the originals of the documents that arrived with the air cargo: air waybill (AWB), invoices, etc. They can be obtained from the information room on the first floor of the customs building. To receive them, you must show your passport and a power of attorney from the recipient to the person who will receive the cargo (the original is taken when receiving the air cargo from the warehouse). If the recipient is physical. the person who is indicated in the air waybill does not need a power of attorney.

In case of receiving cargo for physical. persons with another special power of attorney must be notarized. If you are going to pay for the services of the cargo terminal by bank transfer, then take an account in advance in the settlement department of the Boryspil.

After completion of customs clearance of import, the customs inspector on the original air waybill (a copy with a bunch of customs, airport stamps, handwritten notes) puts a round seal of the release of the cargo for free circulation. On it, a plate is filled out (by a customs inspector or a customs broker who processed it) with data on the document on the basis of which the cargo was issued - a customs declaration.

Next, you need to pay for their services in the settlement department of the Boryspil international airport.

To pay for the services of the Boryspil cargo terminal, you will need the first copy of the air waybill with the warehouse stamps on the acceptance of the air cargo. If you represent a legal entity and use the services of a cargo terminal for the first time, then you will need to provide (can be shown electronically) a knight from the State Register or a certificate of registration of an enterprise and a

certificate of a VAT payer (if any). This is required regardless of whether you pay in cash or by bank transfer. If you are a representative of a freight forwarder or a customs brokerage company and want to pay an invoice on behalf of your company, you must provide (you can copy) a power of attorney from the recipient to pay for the terminal services.

The amount for services depends on the weight, nature of the air cargo, and the number of days of storage. After payment, representatives of the settlement department put a mark on the payment on the air waybill. Today this department also works on weekends until 19:30, but on weekends the banks are closed. Therefore, if you pay by bank transfer, then it is better to take the invoice in advance, without the receipt of money, they will not put a mark on payment. After customs clearance of import and payment for terminal services, for the arrival of a car for picking up air cargo from the warehouse of the Boryspil airport, it is necessary to issue a pass for the car to enter the territory of import warehouses. (warehouse 1-3). Since August 2020, new rules have been introduced for cars entering the territory of import warehouses. (warehouse 1-3). A permit to enter a car is now issued in a room near the barrier at the entrance. It is necessary to provide a formalized air waybill with an oval customs seal. After receiving the cargo, the customs inspector puts a mark on the pass, which must be handed over when leaving.

After that, you can enter the warehouse territory. It should be noted that the cargo can only be picked up by vehicles with Ukrainian numbers. It is prohibited to enter the territory of warehouses for cars with foreign license plates [5].

Employees of the "Boryspil" cargo terminal who are engaged in the delivery of cargo (storekeepers) are located near the 1st warehouse (the first door on the left). To receive cargo from the warehouse of the Boryspil cargo terminal, you need to provide the following documents:

1) An air waybill with customs marks and a stamp confirming payment for terminal services;

2) Power of attorney to receive cargo;

3) Confirmation of receipt (Note of delivery).

When registering for export, arrival at the territory of export warehouses to deliver cargo to the warehouse is possible only thanks to the air waybill. When registering for import, it will be possible to call in only after the registration of air cargo and the provision of air transport.

Arrange the placement of cargo in a temporary storage warehouse, which includes:

1) Verification of the compliance of the data declared in the cargo customs declaration and in the issued MAWB / HAWB.

2) Verification of the conformity of packaging and labeling of cargo for transportation by air, taking into account the nature of the cargo and the conditions of its transportation / handling / storage. If necessary, invite a representative of the airline.

In case of discrepancy in the packaging, depending on the scope of work on the organization of additional packaging:

 - arrange additional packaging

 - agree on the cost of additional packaging services with the client

 - do not accept the goods for transportation and ask the client to provide additional packaging.

3) Take photos of the outer packaging and labeling of the goods before delivery to the warehouse.

4) To issue a Declaration of Security for the security service Boryspil.

Execute export customs procedures. Transfer the completed documents to the airline to send the cargo. Send scanned copies of MAWB / HAWB to the airline for cargo manifestation for the flight. Additionally (if necessary) agree up to which time the documents can be entered

In the volume of foreign trade traffic, goods transported by air transport have no more than 2% of the total tonnage. Moreover, in monetary terms, they make up

35-40% of the trade turnover. That is, by air expensive cargo is transported. At the same time, for airlines, cargo transportation is no less profitable than business class passenger transportation. Service cargo transportation at the airport requires the creation of special conditions for various categories of cargo.

- valuable cargo - currency in banknotes or coins, securities, credit and bank cards, jewelry, precious metals, precious or semi-precious stones, including industrial diamonds, and valuable art objects;

- dangerous goods are products or substances that, when transported on aircraft can pose a significant threat to life and health passengers, flight safety and property safety;

- perishable goods - vegetable or animal products origin and their processing, live plants, fish seed, etc., which require special conditions during storage and transportation (optimal temperatures, humidity, etc.); they are accepted for carriage only with a registered certificate (passport) of quality and transported, as a rule, by direct flights in time, ensuring the safety of the cargo;

- heavy cargo - the weight of one package of which exceeds 80 kg (see Fig.1.2);

Fig. 1.2 Heavy cargo is loading into aircraft compartment

- lightweight cargo - the volume of which is more than 0.008 m3 (8000 cm3) per 1 kg gross;

- bulk cargo - weight of 1 m3 of which is less than 167 kg.

Unaccompanied baggage registered with a bill of lading is also considered cargo. Valuable, perishable, dangerous goods, livestock are classified as special

cargo. If they are on board, this is reflected in the messages about loading (see Fig. 1.3) the aircraft using special codes. IATA standard codes contained in Chapter 10 "Principles of Organization of Loading and Unloading Operations aircraft " developed by this organization. Transportation of the living animals are regulated by the IATA "Live Animals Regulations".
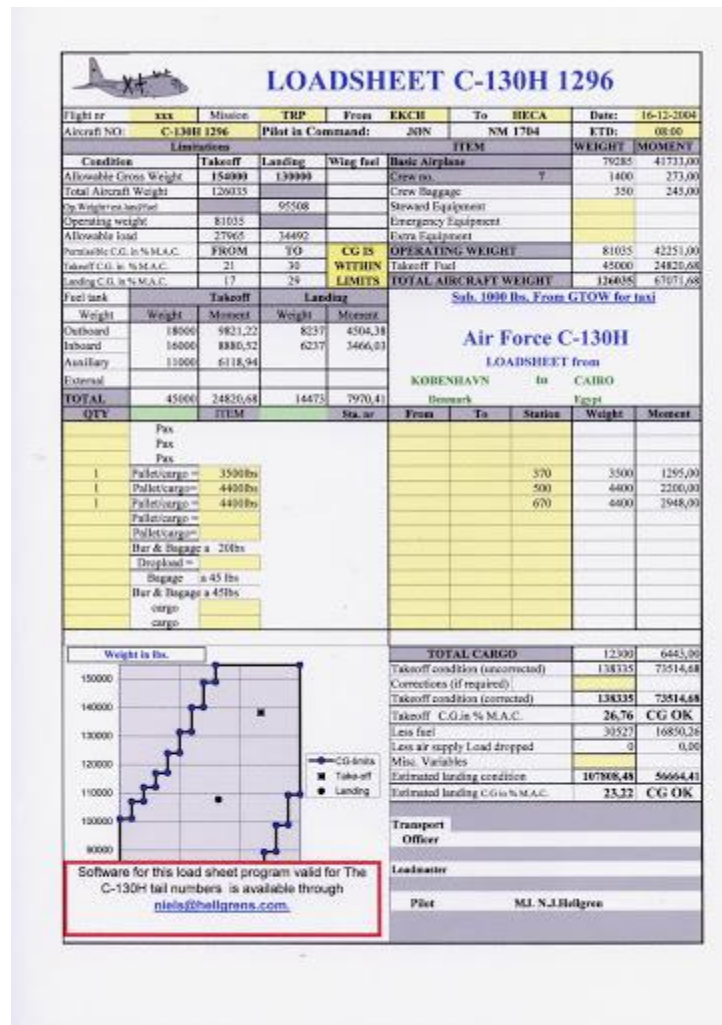

Fig.1.3 Example of Loadsheet

Goods with a declared value, goods, by their nature, having increased value (products made of fur and silk, furs, radio components, etc.), the value of which is not declared, as well as perishable goods flight attendant accepts at the cargo warehouse with obligatory weight check.

Sealed goods, including those with a declared value, are accepted at aircraft board with obligatory check of the packaging serviceability, presence of seals and their compliance with the mark on the waybill.

Cargo or mail transported with escort is accepted on board aircraft only in the presence of an accompanying person. Responsibility for safety such cargo and mail is assigned to the accompanying person, the flight attendant must provide him with possible assistance in ensuring the safety of the cargo. For each category of cargo, transportation technologies have been developed, warehousing and storage at the airport. Most common transportation cargo in containers, on pallets and in bulk (see Fig 1.4).
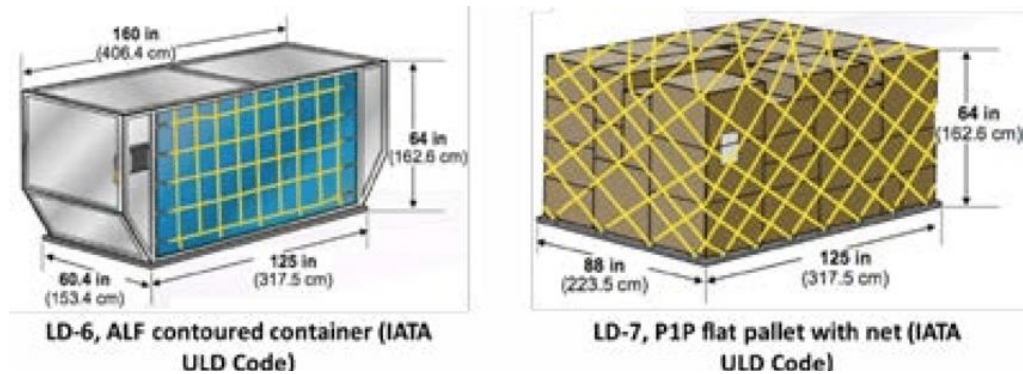

Fig. 1.4 Example of container and pallet

In cargo complexes with a significant volume of container traffic, for parking cargo aircraft there must be cargo aprons are provided adjacent to the main building of the cargo complex.

The airport has special container sections equipped with means of mechanization, equipment for the repair and storage of containers. For maintenance of containers in functional condition is carried out monthly and seasonal maintenance. The technological process of ground handling of goods during their transportation to containers and pallets consists of the following operations:

1) a selection of documentation and cargo for the flight and transportation from storage sites to area for picking containers (pallets);

2) completing containers (pallets) with their sealing and registration documentation for them;

3) materially responsible storage of assembled containers (pallets) in horn racks or on a cargo ramp;

4) formation of the load for the dispatched flight;

5) reloading containers (pallets) onto vehicles;

6) transportation of containers (pallets) from the warehouse to the aircraft parking area and back;

7) loading (unloading) containers or pallets on the aircraft with the transfer material responsibility;

8) mooring of containers (pallets).

Containers with cargo that arrived at the destination airport in good condition, with correct seals of the sender are transferred to the recipient without checking the quantity places, condition and weight of the cargo. When transporting goods in containers, the flight attendant accepts them in quantity, checking the serviceability, presence and safety of seals and verifies the correspondence of the numbers of containers and seals with the postal and cargo sheet. Technological process of ground handling of goods during their transportation in bulk includes the following operations:

1) delivery of goods to the airport by forwarding companies, by shippers or by the airport's own transport;

2) registration of the consignment note of the sender;

3) unloading of goods from vehicles;

4) weighing, marking and registration of the consignment note;

5) warehousing, storage with material responsibility;

6) selection of documentation and cargo for the flight and transportation from storage sites to flight picking area;

7) reloading onto vehicles;

8) transportation from the warehouse to the aircraft parking area;

9) loading of goods into the aircraft with the transfer of liability;

10) cargo mooring.

The discussion of cargo arriving at the airport is carried out in the technological sequence, reverse processing of the goods being sent.

1.6 Statistical data of the cargo terminal

During the following period 2016 - 2020, 29 domestic passenger and cargo airlines operated in the air transportation market. 18 airlines from them performed cargo and mail transportation, most of which were carried out by charter flights and within the framework of UN peace keeping programs, or due to contracts and agreements with other customers.

Statistics of traffic volumes for 2016 compared to the previous year, freight traffic increased by 5.2% and amounted to 74,300 tons. About 98 percent of total passenger and cargo-mail flows are concentrated in 7 leading airports - Boryspil, Kyiv Zhulyany, Odessa, Lviv, Kharkiv, Dnipropetrovsk and Zaporizhya. (see Fig. 1.2).
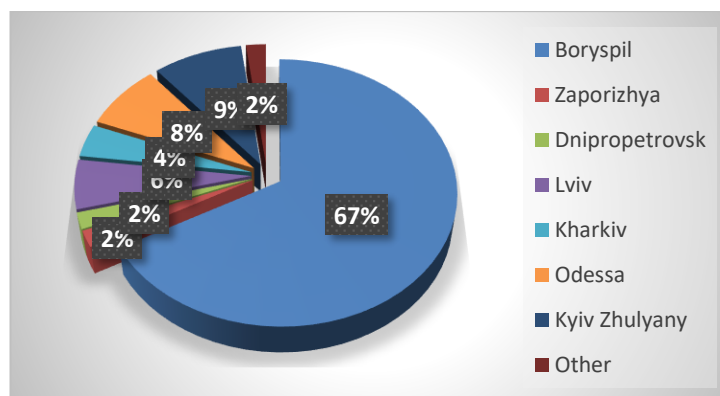

Fig. 1.2 Cargo turnover during 2016 (%) [7]

In 2017 domestic aviation companies ensured the growth of the main economic indicators of the industry. At the same time, according to statistics, the number of transported goods and mail increased by 11.4 percent and amounted to 82.8 thousand tons. It should be noted that 98 percent of mail flows are concentrated in 7 leading airports, namely Boryspil, Kyiv Zhulyany, Odessa, Lviv, Kharkiv, Dnipropetrovsk and Zaporizhya. At the same time, the share of the country's main airport "Boryspil" in the total volume of passenger traffic decreased from 67 percent in 2016 to 64 percent in 2017 and at the same time slightly

increased the share of airports "Kyiv (Zhulyany)", "Lviv" and "Kharkiv". (see Fig.1.3).
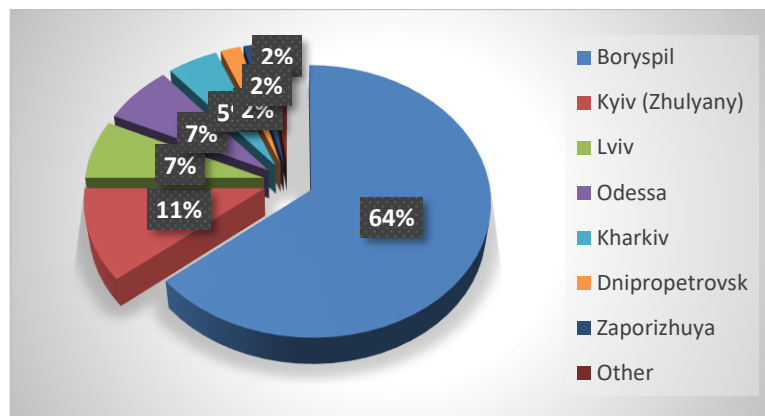

Fig. 1.3 Cargo turnover during 2017 (%) [7]

Statistics on the activities of the aviation industry in 2018 indicate its stable development. During the reporting year, 34 domestic airlines carried passengers, cargo and mail, which performed 100.3 thousand commercial flights (in 2017 - 93 thousand flights). At the same time, the number of transported passengers increased compared to 2017 by 18.7 percent and amounted to 12,529 thousand people. At the same time, the volume of cargo transportation and mail by air transport of Ukraine increased by 19.7 percent and amounted to 99.1 thousand tons. (see Fig. 1.4).
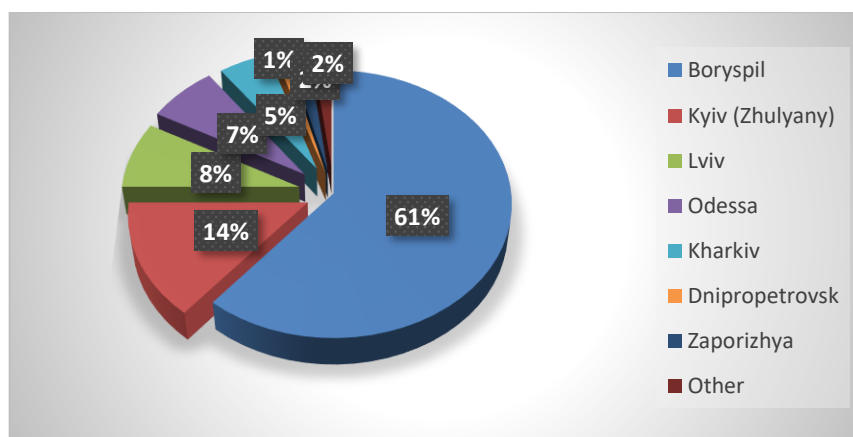

Fig. 1.4 Cargo turnover during 2018 (%) [7]

During 2019 year, the volume of cargo and mail transportation by air transport of Ukraine amounted to 92.6 thousand tons. Cargo and mail were transported by 20 domestic airlines. Leaders of cargo transportation are SE Antonov, Ukraine International Airlines, ZetAvia, Maximus Airlines and Yuzhmashavia. These airlines performed almost 85 percent of the total cargo and mail traffic in the reporting year. The most popular directions are Pacific Asia and Europe, then Middle East, North America, South America and Africa. It should be noted that most cargo has traditionally been charter flights to other countries. (see Fig. 1.5).
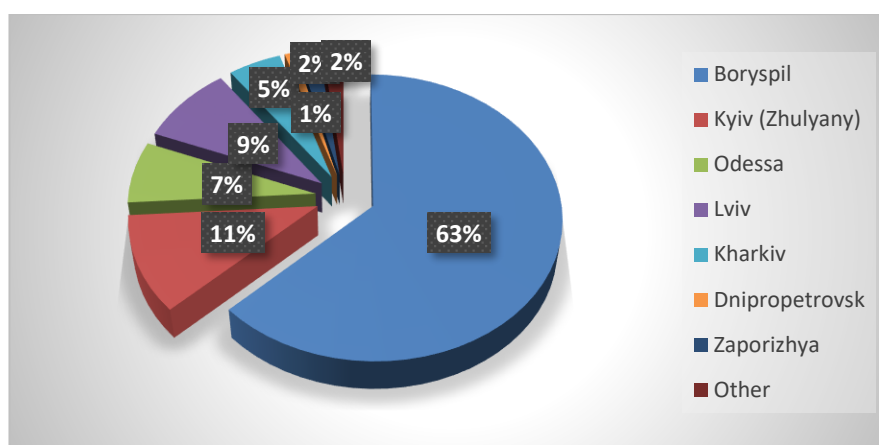

Fig. 1.5 Cargo turnover during 2019 (%) [7]

The pandemic situation in the world, associated with the outbreak of acute respiratory disease COVID-19, and restrictions imposed by states to combat its spread, have directly affected the aviation industry of the world, including Ukraine, where the results In 2020, there is a significant reduction in the production performance of aviation enterprises compared to the previous year. During 2020, passenger and cargo transportation was carried out by 26 domestic airlines (29 - in 2019), which in total performed 45.3 thousand commercial flights (against 103.3 thousand flights in 2019). According to the results of 2020, the volumes of cargo and mail transportation by air transport of Ukraine amounted to 88.3 thousand tons (for 2019 - 92.6 thousand tons) (see Fig. 1.6).
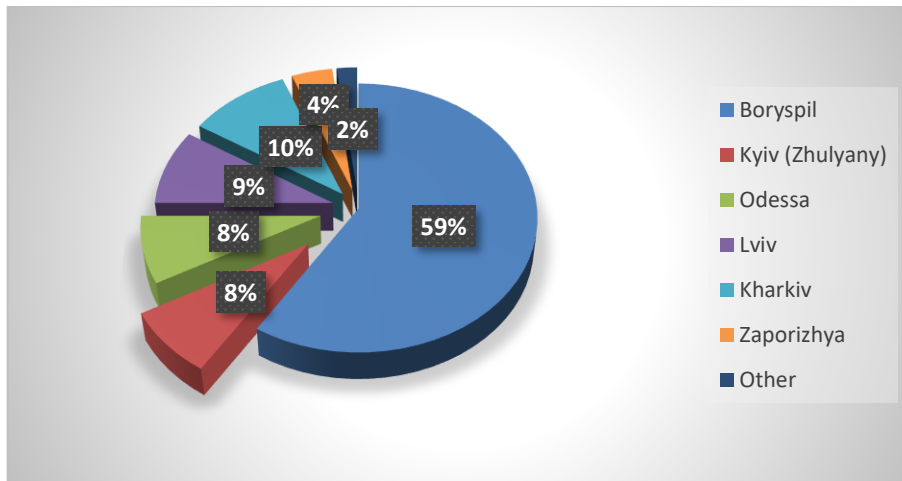
Fig. 1.6 Cargo turnover during 2020 (%) [7]

In the first quarter of 2021, 24 domestic airlines operated on the passenger and freight transportation market. According to statistics, 10.3 thousand commercial flights were performed during the reporting period. The volume of cargo and mail transportation by Ukraine increased by 15.7 percent and amounted to 19.9 thousand tons compared to the 1st quarter of last year. Cargo and mail were transported by 17 domestic airlines. The leaders of transportation are SE Antonov, ZetAvia, Fly Sky Airlines, Constanta, Maximus Airlines, Kavok Air and Ukraine International Airlines. These airlines performed 90 percent of the total cargo and mail traffic in the reporting period. (see Fig. 1.7).
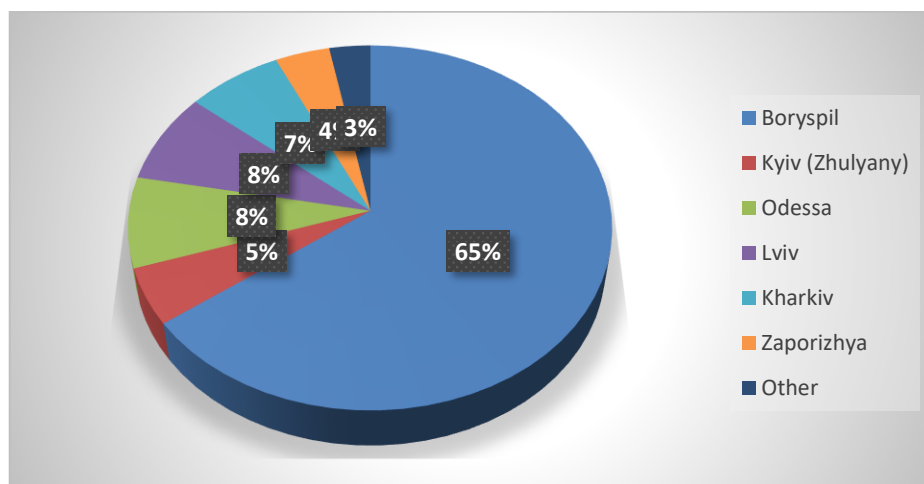

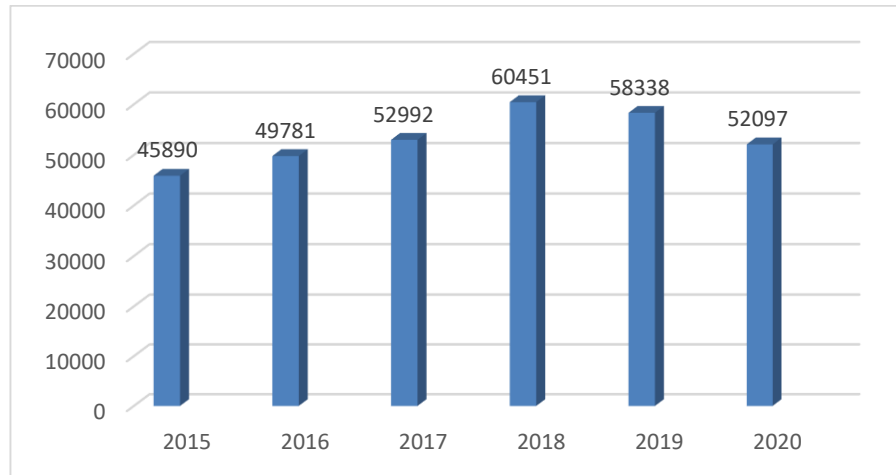Fig. 1.7 Cargo turnover during 1-st quarter of 2021 (%) [7]

Fig. 1.8 Cargo turnover of Boryspil airport 2015-2020 (tons)

1.7 Perspectives of development of the cargo terminal

Prospective development of freight traffic in Boryspil is possible only in new production conditions. The increase in volumes in 2017 showed a real trend for sustainable growth. Therefore, the financial plan for 2021 provides for the costs of technical re-equipment and an increase in the payroll for the cargo terminal.

Assessing the current situation with cargo in Boryspil, analyzing the factors that led to a difficult situation with cargo handling this year, I would also like to focus on the reasons and factors of changes that await us.

Today, the average daily volume of cargo handling by our terminal is 120 tons, and the maximum possible in terms of production space is 200 tons per day [8].

There was developed and began to implement an action plan to bring technology, technical and human resources to the required level to ensure the growing traffic flow. However, the limitation of 200 tons per day for cargo handling is due to the impossibility of storing more than 800-900 tons in existing areas. Simply put, all these measures are temporary and long-term development is possible only in new production conditions, in new areas, where the factor of extensive growth will be taken into account [9] .

Theft has an extremely negative effect on the operation of the cargo terminal. In order to prevent theft, the airport security service began to actively work with this phenomenon. Recently, footage of the inappropriate behavior of Boryspil airport employees circulated on the Internet. This phenomenon must be fought with all available methods.

The security service conducted a large number of official investigations and turned over the results to law enforcement officials, but only a few cases were brought to trial. Today there is no factor of inevitability of punishment. The worst thing that can happen to an employee who has made unauthorized access to cargo is dismissal [10].

Firing, in turn, implies hiring employees with higher morale. And this is not an easy question, even with the increase in wages. After all, the loader must also be organized and competent enough to work with the documents accompanying the receipt of the cargo. The lack of supply in the labor market today has led to a 10 percent labor shortage.

The efficiency of the technical means depends on the optimal ratio of the price and quality of the equipment. At the moment, the airport conducts purchases in the ProZorro system, where the main factor is price, not reliability. This inexpensive technique does not provide the required technical parameters in difficult climatic conditions, it regularly fails [11].

Therefore, with the support of Ukrposhta, which already has successful experience, the airport is exploring the possibility of purchasing equipment on lease. We hope this procedure will help improve the situation.

Since the reconstruction of warehouses was not carried out at the proper level in previous years, this year the 5th warehouse will be reconstructed as soon as possible. New racking systems will be installed there, providing 600 additional pallet spaces. A new X-Ray machine will also be installed, which will make it possible to process the transfer faster. At the 6th warehouse there will be separate rooms for transfer animals with all the necessary conditions, as well as a separate

room for valuable goods. The reconstruction will also affect the import warehouse and warehouse No. 7.

Today's technology is such that cargo and mail from the side of passenger flights (and this is up to 70% of the volume) is transported directly to the cargo terminal. This technology gives loaders the opportunity for unauthorized access to cargo. We see the need to limit the responsibility of the cargo terminal for the safety and completeness of cargo only by its territory and to strengthen control at the position of transferring cargo to the warehouse. Responsibility for the delivery of goods to the warehouse from the side, along with the delivery of passengers and their luggage, should be assumed by the handling companies - representatives of the carrier. After all, it is the airlines that are responsible for the cargo to the sender until it is accepted into the warehouse. To simplify the work, the airport will allocate areas for handlers in front of the cargo terminal for accumulating cargo before issuing it to the cargo terminal. At the same time, the transfer of responsibility for the cargo should not take place under the board, where quality control over the safety and completeness is impossible, but directly during transfer to the warehouse. Thus, we strive to create an environment in which irresponsible theft becomes impossible [6].

In this case, we are not talking about cargo flights - they will still be serviced by the personnel of the cargo terminal.

Today, cargo transported by air is premium goods. The limited purchasing power of the population restrains a sharp increase in the transport of goods in this segment. However, taking into account our growth results from the use of the hub model in passenger transportation, it seems logical also to implement the technology of sorting transit cargo in Borispol. If the transfer is convenient for passengers, it will be convenient for cargo as well.

The volume of passenger cargo transportation is growing. The flagship of the UIA base airline Boeing 777 alone is capable of carrying up to 25 tons of cargo [12]. And we feel a growing need to handle transit cargo. Within the framework of the airport development strategy, the territory has been determined where the cargo

logistics complex will develop in the future. In general, the development of "Boryspil" will take place with a clear zoning of various production sites, according to the European approach to the development of the airport - not chaotically, but systematically. This is determined by the strategic plan for the development of the airport, developed jointly with the Austrian company "Airport Consulting Vienna". The strategy is now under consideration by the Cabinet of Ministers, and we hope that it will be approved soon [13].

Some companies are ready to invest both $ 30 million and $ 50 million in the development of a cargo terminal as a sorting center. The implementation of this investment project will provide conditions for better and more logical export-import operations, and not the "old-fashioned" technology that we are using now. For this reason, we are focused on the construction of a new facility.

DESIGN PART

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2.1 Calculation of working area of airport cargo complex

Currently is carried out designing of a new Boryspil cargo terminal for which already were given areas. After completion of all plans the construction work should be carried out within 16 months. According to optimistic view new cargo terminal will be finished in the end of 2021. Now the Ministry of Infrastructure simplifies documents turnover and negotiates with Eastern countries for attraction new transit flows. Many forwarding companies wait for this project because they have large share in the cargo flow through the Boryspil [14].

In order to predict cargo turnover at Boryspil cargo terminal we use trend line forecast method. Trend lines are a geometric representation of the average values of the analyzed indicators, obtained using any mathematical function. The choice of function to build a trend line is usually determined by the nature of data change over time (see Fig. 2.1) [16].
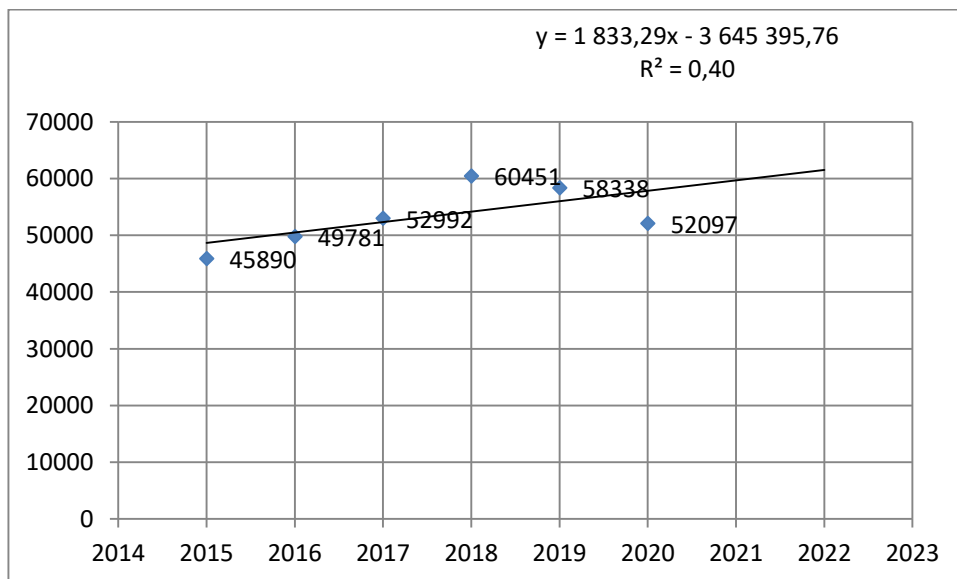

Fig. 2.1 Forecast of cargo turnover (tons) by trend line method

After completion of the Fig 2.1 we use following formula:

$$Y = a + bx, \qquad\qquad (2.1)$$

where a – intercept (base level);

b –slope (trend);

x – predicted year.

Y=-3645395+1833*2021=59098 (tons) during 2021

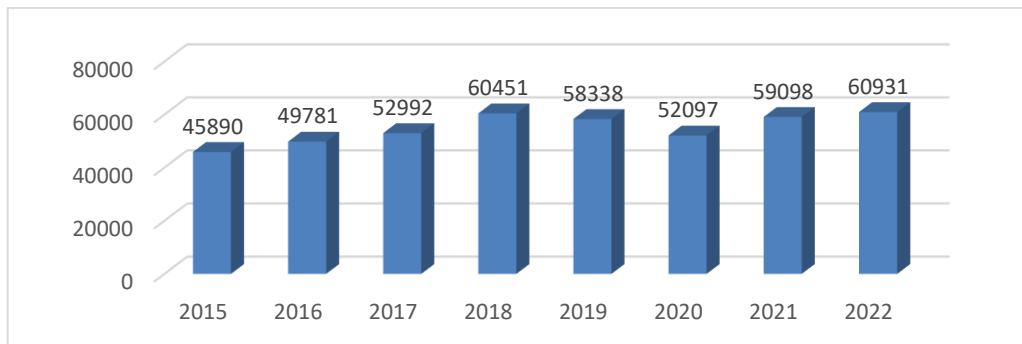Y=-3645395+1833*2022=60931 (tons) during 2022, (see Fig. 2.2).

Fig. 2.2 Forecast for cargo turnover during 2021 and 2022 period (tons)

The airport plans to build a new modern cargo complex of 15 thousand square meters, which will work with export and import cargo, and then - to reconstruct the old warehouses (another 7-8 thousand square meters with daily cargo turnover 100 tons/day) and convert them into a specialized warehouse for the rapid sale of products. So expected cargo turnover of both terminals is 300 tons/day [15].
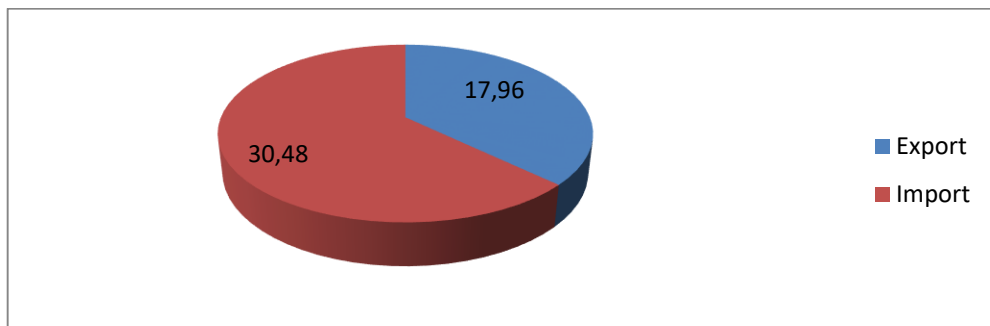

Fig. 2.3 Ratio between different cargo flows of domestic airlines(DAL) at KBP during forecast period 2022 (tons/day)
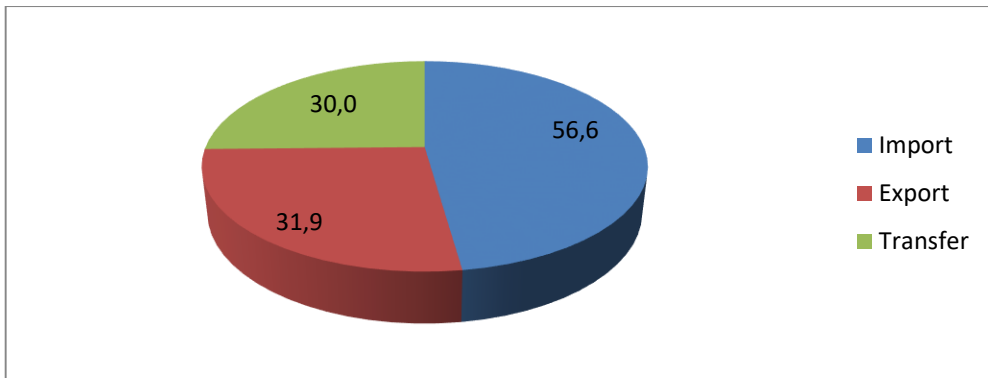
Fig. 2.4 Ratio between different cargo flows of international airlines(IAL) at KBP during forecast period 2022 (tons/day)
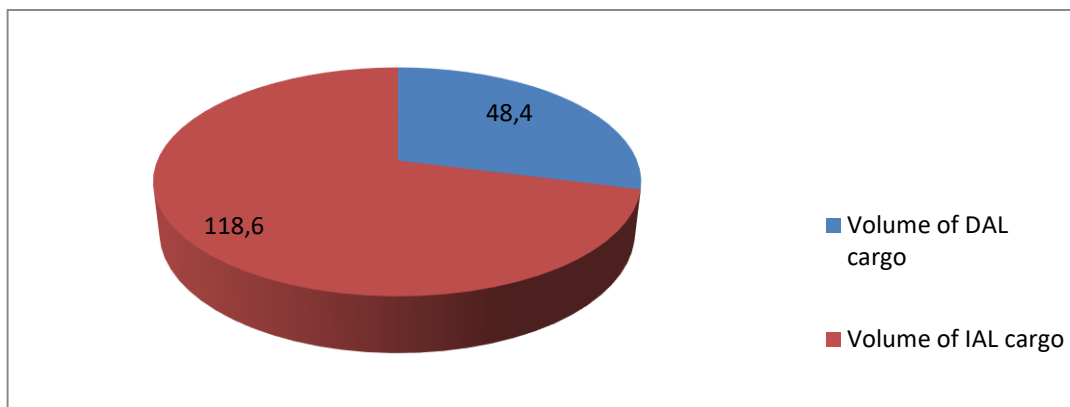
Fig 2.5 Ratio between DAL and IAL cargo turnover at KBP in 2020 (tons/day)

Table 2.1.

Cargo flow characteristics

1	2	3	4	5	6	7
Daily goods Turnover (Q_{day})	Specific weight of goods on DAL, (K^{DAL}_{Total})	Specific weight of goods arrived by DAL, (K^{DAL}_{Import})	Specific weight of goods arrived by IAL, (K^{IAL}_{Import})	Specific weight of goods transferred by IAL, $(K^{IAL}_{Transfer})$	Specific weight of bulk cargo transported by IAL, (K^{IAL}_{Bulk})	Coefficient of nonunifor-
167	0,289	0,629	0,477	0,25	0,2	1,5

$Q_{Total}^{DAL}=Q_{day}*K_{Total}^{DAL}=167*0{,}289=48{,}4(\frac{tons}{day})$, it is a total volume of DAL cargo.

$Q_{Import}^{DAL}=Q_{Total}^{DAL}*K_{Import}^{DAL}=48{,}4*0{,}629=30{,}48(\frac{tons}{day})$, it is a volume of DAL cargo, that arrived .

$Q_{Export}^{DAL}=Q_{Total}^{DAL}-Q_{Import}^{DAL}=48{,}4-30{,}48=17{,}96(\frac{tons}{day})$, volume of departured DAL cargo.

$Q_{Total}^{IAL}=Q_{day}-Q_{Total}^{DAL}=167-48{,}4=118{,}6(\frac{tons}{day})$, it is a total volume of IAL cargo.

$Q_{Import}^{IAL}=Q_{Total}^{IAL}*K_{Import}^{IAL}=118{,}6*0{,}477=56{,}61(\frac{tons}{day})$, it is a volume of IAL cargo, that arrived.

$Q_{Transfer}^{IAL}=Q_{Total}^{IAL}*K_{Transfer}^{IAL}=118{,}6*0{,}25=30(\frac{tons}{day})$, volume of IAL cargo for transfer.

$Q_{Export}^{IAL}=Q_{Total}^{IAL}-Q_{Import}^{IAL}-Q_{Transfer}^{IAL}=118{,}6-56{,}61-30=31{,}93(\frac{tons}{day})$, volume of departured AIL cargo.

$Q_{Bulk}=Q_{Total}^{IAL}*K_{Bulk}^{IAL}=118{,}6*0{,}2=18{,}56(\frac{tons}{day})$, volume of AIL cargo in bulk.

$Q_{ULD}=Q_{day}-Q_{Bulk}^{AIL}-Q_{Import}^{DAL}-Q_{Export}^{DAL}=167-18{,}56-30{,}48-17{,}96=100(\frac{tons}{day})$, volume of AIL cargo in ULD, where Q_{Import}^{DAL} and Q_{Export}^{DAL} are also in bulk (see Fig. 2.6).
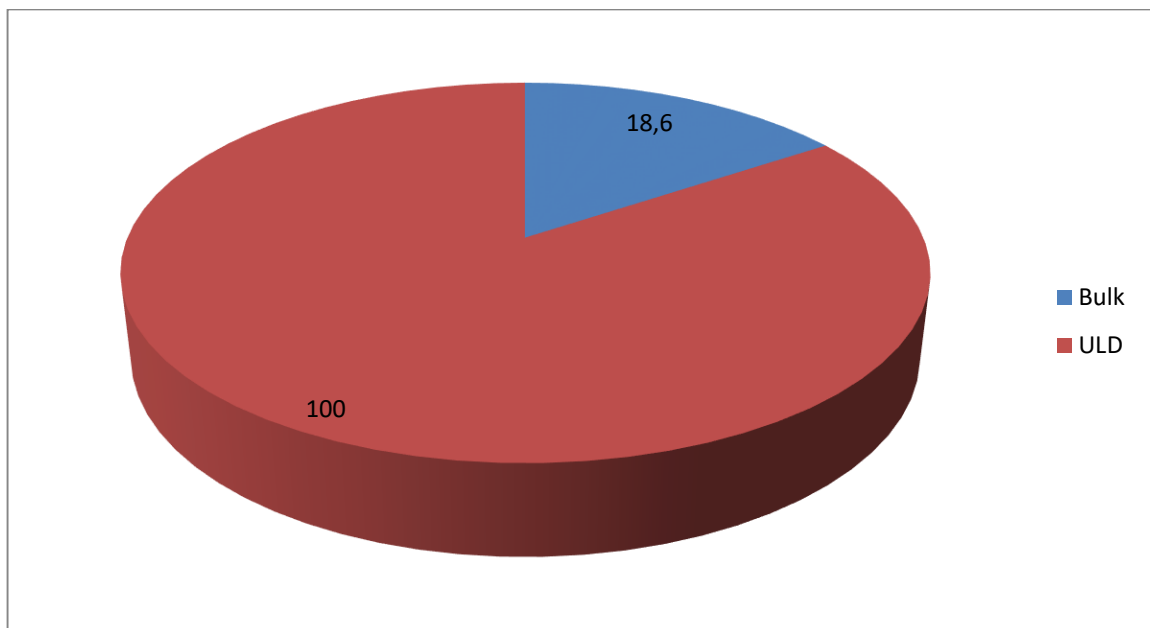
Fig. 2.6 Ratio between Bulk and ULD at KBP (tons/day)

2.2 Calculation of working area of airport cargo complex

2.2.1 Calculation of capacity of warehouse premises

Calculation of capacity of warehouse premises determines volume of stored cargo under one roof at any time, it can be expressed by following formula:

$$E_{warehouse} = Q_{day} * K_n * T_{st}^{av} ,$$ (2.2)

where Q_{day} - is daily goods turnover of an airport on goods departure or arriving, t/day;

K_n - is coefficient that takes into account nonuniformity of goods delivery at warehouse during different seasons and months of a year;

T_{st}^{av} - is average duration of goods storage at warehouse, days.

For export:

$E_{War.export}^{DAL} = Q_{Export}^{DAL} * K_n * T_{st.\ export}^{av} = 17,96*1,5*1,5 = 40,41$(tons) capacity of premises for DAL export cargo.

$E_{War.\ export}^{IAL} = Q_{Export}^{IAL} * K_n * T_{st.\ export}^{av} = 31,93*1,5*1,5 = 71,84$(tons) capacity of premises for IAL export cargo.

For import:

$E_{War.\ import}^{DAL} = Q_{Import}^{DAL} * K_n * T_{st.\ import}^{av} = 30,48*1,5*1,5 = 68,58$(tons) capacity of premises for DAL import cargo.

$E_{War.\ import}^{IAL} = Q_{Import}^{IAL} * K_n * T_{st.\ import}^{av} = 56,61*1,5*1,5 = 127,37$(tons) capacity of premises for IAL import cargo.

For transfer:

$$E_{\text{War. transfer}}^{\text{AIL}} = Q_{\text{Transfer}}^{\text{AIL}} * K_n * T_{\text{st. transfer}}^{\text{av}} = 30*1{,}5*0{,}6 = 27(\text{tons}) \text{ capacity of premises for}$$

IAL transfer cargo.

2.2.2 Calculations of working area of warehouse

$$F_{\text{Wor.}}^{\text{fl}} = \frac{E_{\text{War.}}^{\text{fl}}}{P^{\text{fl}}} * K_{\text{sur.ar.}} = \frac{[t]}{\left[\frac{t}{m^2}\right]} * [\text{coefficient}] = [m^2] \, , \tag{2.3}$$

where $E_{\text{War.}}^{\text{fl}}$ - is capacity of premises, intended for storage of goods on floor or in stacks, t;

P^{fl} - is specific loading, allowed per 1 m^2 of warehouse area, $\frac{t}{m^2}$;

$K_{\text{sur.ar.}}$ - is coefficient of surplus area that takes into account irregularity of goods distribution.

For export:

$$F_{\text{Wor. export}}^{\text{fl. DAL}} = \frac{E_{\text{War. export}}^{\text{DAL}}}{P^{\text{fl}}} * K_{\text{sur.ar.}} = \frac{40{,}41}{0{,}06} * 1{,}2 = 808{,}2 \, [m^2] \text{ working area for DAL cargo}$$

export.

For import:

$$F_{\text{Wor. import}}^{\text{fl. DAL}} = \frac{E_{\text{War. import}}^{\text{fl. DAL}}}{P^{\text{fl}}} * K_{\text{sur.ar.}} = \frac{68{,}58}{0{,}06} * 1{,}2 = 1371{,}16 \, [m^2] \text{ working area for DAL cargo}$$

import.

2.2.3 Calculations of number of stacks

$$n_{\text{st}} = \frac{F_{\text{Wor.}}^{\text{fl}}}{F_{\text{st}}} = \frac{[m^2]}{[m^2]} = [1] \, , \tag{2.4}$$

where $F_{\text{Wor.}}^{\text{fl}}$ working area of warehouse;

$F_{\text{st}} = 6(\text{length})*4(\text{width}) = 24[m^2]$ is area of one stack.
For export:

$$n_{st.\ export} = \frac{F_{Wor.export}^{fl.\ DAL}}{F_{st}} = \frac{808,2}{24} = 33,67 \approx 34 \text{ [pieces]}$$

For import:

$$n_{st.\ import} = \frac{F_{Wor.\ import}^{fl.\ DAL}}{F_{st}} = \frac{1371,16}{24} = 57,13 \approx 58 \text{ [pieces]}$$

2.2.4 Calculations of volume of a rack's working cell

$$v_c = l*b*h = [m]*[m]*[m] = [m^3] \ , \tag{2.5}$$

where   l - is length of a cell, m;

b - is width of a cell, m;

h - is height of a cell, m.

$$v_c = 1,3*1,0*1,1 = 1,43 \ [m^3]$$

2.2.5 Calculation of the specific capacity of a rack's cell

$$E_c = v_c*\gamma*K_f = [m^3]*\frac{[t]}{[m^3]}*[\text{coefficient}] = [t] \ , \tag{2.6}$$

where v_c - volume of a rack's working cell;

γ - is volume weight of stored goods, $\frac{[t]}{[m^3]}$;

K_f - is coefficient of a cell filling with goods.

$$E_c = 1,43*1,1*0,5 = 0,7865 \ [t]$$

2.2.6 Calculations of number of racks working cells

$$N_c = \frac{E_{cell}^{rack}}{E_c} = \frac{[t]}{[t]} = 1 \ , \tag{2.7}$$

where E_{cell}^{rack} - specific capacity of stored goods;

E_c - specific capacity of a rack's cell.

$E_{cell}^{rack} = E_{War. \ export}^{IAL} + E_{War. \ import}^{IAL} + E_{War. \ transfer}^{IAL} = 71,84 + 127,37 + 27 = 226,21$ [t]- specific capacity of stored goods.

$$N_c^{export} = \frac{71,84}{0,7865} = 91,34 \approx 92 [pieces]$$

$$N_c^{import} = \frac{127,37}{0,7865} = 161,94 \approx 162 [pieces]$$

$$N_c^{transfer} = \frac{27}{0,7865} = 34,32 \approx 35 [pieces]$$

$$N_c = 119 \ [pieces]$$

2.2.7 Calculations of number of racks tiers

$$K_t = \frac{P^{rack} * F_c}{E_c} = \frac{\frac{[t]}{[m^2]} * [m^2]}{[t]} = [pieces] \ , \tag{2.8}$$

where P^{rack} - is specific loading, allowed per 1 [m^2] of warehouse floor with rack storage of goods, $\frac{[t]}{[m^2]}$;

$F_c = l * b = 1,3 * 1,0 = 1,3 \ [m^2]$ - is area of one cell;

$K_t = \frac{3,2*1,3}{0,7865} = 5,28 \approx 5 \ [pieces]$, if calculation result is non integer it should be rounded down.

2.2.8 Calculation of number of working cells in the lower tier of racks

$$Z_c^l = \frac{N_c}{K_t} = \frac{[1]}{[1]} = [\text{pieces}] \, , \tag{2.9}$$

where K_t - number of racks tiers;

N_c - number of racks working cells.

$$Z_c^l = \frac{119}{5} = 23,8 \approx 24 [\text{pieces}]$$

2.2.9 Calculation of total working area of warehouse section

$$F_{wor}^{rack} = (l + b^\tau) * b * Z_c^l \, , \tag{2.10}$$

where Z_c^l - number of working cells in the lower tier of racks;

b - is width of a cell, m;

$b^\tau = 0,1$ [m] - is width of gaps between neighboring cells, m.

$$F_{wor}^{rack} = (1,3 + 0,1) * 10 * 24 = 336 \approx 340 \, [\text{m}^2]$$

2.3 Calculation of additional area of warehouse

$$F_{ad.} = \frac{Q_{day} * t}{P^*} = \frac{\frac{[t]}{[day]} * [days]}{\frac{[t]}{[m^2]}} = [\text{m}^2], \tag{2.11}$$

where   t - is term of goods storage at the acceptance and consolidation area, days;

P^* - is loading per 1 [m^2] at the acceptance and consolidation area, $\frac{[t]}{[m^2]}$;

Q_{day} – cargo turnover per day.

$$F_{ad.}^{DAL} = \frac{48,44*0,5}{0,07} = 346 \ [m^2]$$

$$F_{ad}^{IAL} = \frac{118,54*0,5}{0,07} = 846,71 \approx 847 \ [m^2]$$

2.4 Calculation of auxiliary area of warehouse

$$F_{aux} = F_{wor}*K_{pas} = [m^2]*[coefficient] = [m^2], \qquad (2.12)$$

where F_{wor}=2179,36 [m^2] for DAL;

F_{wor}=340 [m^2] for IAL;

K_{pas} - is coefficient that takes into account necessity in auxiliary area inside warehouse, occupied by passages.

$$F_{aux}^{DAL} = 2179,36*0,7 = 1525 \ [m^2]$$

$$F_{aux}^{IAL} = 340*0,7 = 238 \ [m^2]$$

2.5 Calculation of office area of warehouse

$$F_{of} = n*S_n = [1]*[m^2] = [m^2] \ , \qquad (2.13)$$

where n - is number of workers at warehouse, persons;

S_n - is normative area per one worker, [m^2].

$$F_{of}^{DAL} = n*S_n = 9*3,25 = 292,5 \approx 295 \ [m^2]$$

$$F_{of}^{IAL} = (n+n_c)*S_n = (9+4)*3,25 = 422,5 \approx 425 \ [m^2]$$

2.6 Calculation of technological parameters of warehouses

$$F_{total}=(F_{wor}+F_{ad}+F_{aux}+F_{of}), \qquad (2.14)$$

where F_{wor} - area, directly occupied by stored goods (working area);

F_{ad} - area necessary for performing operations connected with goods acceptance and delivery (additional area);

F_{aux} - area, occupied by passages (auxiliary area);

F_{of} - area, occupied by offices (office area).

$$F_{total}^{DAL}=F_{wor}^{DAL}+F_{ad}^{DAL}+F_{aux}^{DAL}+F_{of}^{DAL}=2179,36+346+1525+295=4345 \ [m^2]$$

$$F_{total}^{IAL}=F_{wor}^{IAL \ (rack)}+F_{ad}^{IAL}+F_{aux}^{IAL}+F_{of}^{IAL}=340+847+238+425=1850 \ [m^2]$$

2.7 Determination of warehouse overall dimensions

$$L_{war}=\frac{F_{total}}{B_{war}}=\frac{[m^2]}{[m]}=[m] \ , \qquad (2.15)$$

where F_{total} – total area of warehouse;

B_{war} – width of warehouses, which according to the construction standard should be multiple to 3. It can be 12, 18, 24, 36 or 48 [m]

$$L_{war}^{DAL}=\frac{F_{total}^{DAL}}{B_{war}}=\frac{4345}{72}=60,34\approx72 \ [m \ ]$$

$$L_{war}^{IAL}=\frac{F_{total}^{IAL}}{B_{war}}=\frac{1850}{24}=77,08\approx72 \ [m \ ]$$

2.8 Calculation of length of the front of loading and unloading works

2.8.1 Optimal number of goods acceptance points

$$n_{opt} = \dfrac{\lambda + \dfrac{1}{t_d^{giv}} * \ln \dfrac{P_{oc}}{P(t_{real} > t_d^{giv})}}{v} \, , \qquad (2.16)$$

where t_d^{giv} – is average waiting time of truck with goods in queue on unloading, hours;

P_{oc} – is possibility that acceptance points will be occupied and next in turn truck with goods will be waiting for unloading;

$P(t_{real} > t_d^{giv})$ – is possibility that downtime of truck in queue on unloading can be bigger than the given one;

$v = \dfrac{1}{[t_{serv}]} = \dfrac{1}{0,4} = 2,5$ – is intensity of one shipper servicing, must be inversely proportional to the average time of one shipper servicing t_{serv};

λ – is intensity of input flow of trucks, pcs/hour.

$$\lambda = \dfrac{Q_{day} * K_n}{T * q_{c.c.} * K_{c.c.}} \, , \qquad (2.17)$$

T – is working time of warehouse during a day from acceptance and delivery of goods from warehouse, hours per day;

$q_{c.c.}$ – is average carrying capacity of trucks, which are used, t;

$K_{c.c.}$ – is coefficient of a truck carrying capacity usage.

$$\lambda^{DAL} = \dfrac{Q_{Total}^{DAL} * K_n}{T * q_{c.c.} * K_{c.c.}} = \dfrac{48,44 * 1,5}{24 * 5 * 0,7} = 0,98 \left[\dfrac{unit}{hour} \right]$$

$$\lambda^{IAL} = \dfrac{Q_{Total}^{IAL} * K_n}{T * q_{c.c.} * K_{c.c.}} = \dfrac{118,56 * 1,5}{24 * 5 * 0,7} = 2,11 \left[\dfrac{unit}{hour} \right]$$

Than,

$$n_{opt}^{DAL}=\frac{\lambda^{DAL}+\dfrac{1}{t_d^{giv}}*\ln\dfrac{P_{oc}}{P(t_{real}>t_d^{giv})}}{v}=\frac{0,98+\dfrac{1}{0,6}*\ln(\dfrac{0,95}{0,05})}{2,5}=$$

$$=\frac{0,98+\dfrac{1}{0,6}*2,944}{2,5}=2,35\approx3\ [units]$$

$$n_{opt}^{IAL}=\frac{\lambda^{IAL}+\dfrac{1}{t_d^{giv}}*\ln\dfrac{P_{oc}}{P(t_{real}>t_d^{giv})}}{v}=\frac{2,11+\dfrac{1}{0,6}*\ln(\dfrac{0,95}{0,05})}{2,5}=$$

$$=\frac{2,11+\dfrac{1}{0,6}*2,944}{2,5}=2,80\approx3\ [units]$$

2.8.2 Length of the front of loading and unloading works

$$L=n_{opt}*l+(n_{opt}-1)*l_{res}\ , \tag{2.18}$$

where l – is length(6,5 [m]) or width(3,0 [m]) of a truck, depending upon the way of trucks arrangement, [m];

$l_{res}=2$ [m] – is reserve distance between neighboring trucks, installed near unloading platform.

$$L^{DAL}=n_{opt}^{DAL}*l+(n_{opt}^{DAL}-1)*l_{res}=3*3+(3-1)*2=13\ [m]$$
$$L^{IAL}=n_{opt}^{IAL}*l+(n_{opt}^{IAL}-1)*l_{res}=5*3+(3-1)*2=19\ [m]$$

2.9 Calculation of mechanized means number

2.9.1 Calculation of mechanized means number in warehouse

$t_1 = 30\ [sec]$ - is time of forks placing under goods, lifting of goods on forks and loaders turn

$$t_2 = t_6 = \frac{L_{load}}{V_{load}} + t_{ac} , \qquad (2.19)$$

where $t_{ac} = 5$ [sec] - is time on acceleration and deceleration or time on reverse idle running..

$$L_{load} = \sqrt{L_{war}^2 + B_{war}^2} , \quad B_{war}^{DAL} = B_{war}^{IAL} , \qquad (2.20)$$

$$L_{load}^{DAL} = \sqrt{(L_{war}^{DAL})^2 + (B_{war}^{DAL})^2} = \sqrt{72^2 + 72^2} = \sqrt{10368} = 101,8 \approx 102 \text{ [m]}$$

$$L_{load}^{IAL} = \sqrt{(L_{war}^{IAL})^2 + (B_{war}^{IAL})^2} = \sqrt{72^2 + 24^2} = \sqrt{5760} = 75,8 \approx 76 \text{ [m]}$$

$$V_{load} = 20 \left[\frac{km}{1 \text{ hour}}\right] = \frac{20000}{3600} \left[\frac{m}{sec}\right] = 5,55 \left[\frac{m}{sec}\right]$$

$$t_2^{DAL} = t_6^{DAL} = \frac{L_{load}^{DAL}}{V_{load}} + t_{ac} = \frac{34}{5,55} + 5 = 11,12 \text{ [sec]}$$

$$t_2^{IAL} = t_6^{IAL} = \frac{L_{load}^{IAL}}{V_{load}} + t_{ac} = \frac{27}{5,55} + 5 = 9,86 \text{ [sec]}$$

$$t_3 = t_5 = \frac{H_{load}}{V_{load\ f}} + t_{ac} , \qquad (2.21)$$

where H_{load} – is average height of loader's forks lifting (fall movement), m;
$V_{load\ f}$ – is speed of loader's forks lifting (fall movement), m/sec.

$t_3 = t_5 = \frac{5}{20} + 5,55 = 5,8$ [sec] - is time of goods lifting on necessary height or time of empty loaders forks down movement.

$t_4 = 11$ [sec] - is time of goods laying in stack and deviation of forklift loader frame backwards without goods.

Than,

Calculation of $T_{c.\,load}$ - duration of one working cycle of forklift loader (sec).

$$T_{c.\,load}=t_1+t_2+t_3+t_4+t_5+t_6 \,, \qquad (2.22)$$

$$T_{c.\,load}^{DAL}=t_1+t_2^{DAL}+t_3+t_4+t_5+t_6^{DAL}=30+11,12+5,8+11+5,8+14,66=78,38 \text{ [sec]}$$

$$T_{c.\,load}^{IAL}=t_1+t_2^{IAL}+t_3+t_4+t_5+t_6^{IAL}=30+13,79+5,8+11+5,8+13,79=76,25 \text{ [sec]}$$

Than,

Calculation of Z_{load} - number of working cycles of electric loader per hour (pcs)

$$Z_{load}=\frac{T_{hour}}{T_{c.\,load}} \,, \qquad (2.23)$$

$T_{hour}=1$ [hours]$=3600$ [sec] - is duration of hour (minutes or seconds);

$$Z_{load}^{DAL}=\frac{T_{hour}}{T_{load}^{DAL}}=\frac{3600}{78,38}=45,93\approx46 \; [\frac{\text{number of working cycles}}{\text{hour}}]$$

$$Z_{load}^{IAL}=\frac{T_{hour}}{T_{load}^{IAL}}=\frac{3600}{76,25}=47,23\approx47 \; [\frac{\text{number of working cycles}}{\text{hour}}]$$

Than,

Calculation of $P_{h\,load}$ - hourly productivity of electric loader (t/hour)

$$P_{h\,load}=Q_{load}*K_{us.\,c}*Z_{load} \,, \qquad (2.24)$$

Q_{load} – is carrying capacity of electric loader, t;

$K_{us.\,c}$ – is coefficient of carrying capacity usage.

$$P_{h\ load}^{DAL}=Q_{load}*K_{us.\ c}*Z_{load}^{DAL}=3,5*0,75*46=120,75\ [\frac{t}{hour}]$$

$$P_{h\ load}^{IAL}=Q_{load}*K_{us.\ c}*Z_{load}^{IAL}=3,5*0,75*47=123,37\ [\frac{t}{hour}]$$

Than,

Calculation of N_{load} - number of electric forklift loaders (units)

$$N_{load}=\frac{Q_{day}*K_n}{P_{h.\ load}*T_{load}*K_{us.t}}=\frac{\left[\frac{t}{day}\right]*[coefficient]}{\left[\frac{t}{hour}\right]*\left[\frac{hour}{day}\right]*[coefficient]}=[unit]\ , \tag{2.25}$$

where $K_{us.t}=0,8$ – is coefficient of vehicle usage during working time.

$$T_{load}=Z_{load}*T_{c.\ load}\ , \tag{2.26}$$

$$T_{load}^{DAL}=Z_{load}^{DAL}*T_{c.\ load}^{DAL}=46*78,38=3605,48\left[\frac{sec}{day}\right]=1[\frac{hour}{day}]$$

$$T_{load}^{IAL}=Z_{load}^{IAL}*T_{c.\ load}^{IAL}=47*76,25=3583,75\left[\frac{sec}{day}\right]=0,99\ [\frac{hours}{day}]$$

$$N_{load}^{DAL}=\frac{Q_{Total}^{DAL}*K_n}{P_{h\ load}^{DAL}*T_{load}^{DAL}*K_{us.t}}=\frac{50*1,5}{120,75*1*0,8}=0,77\approx1\ [unit]$$

$$N_{load}^{IAL}=\frac{Q_{Total}^{IAL}*K_n}{P_{h\ load}^{IAL}*T_{load}^{IAL}*K_{us.t}}=\frac{92,8*1,5}{123,37*0,99*0,8}=1,42\approx2\ [units]$$

Number of electric loaders is integer. If calculation result is non integer it should be rounded up.

2.10 Calculation of mechanized means number on apron

Number of vehicle with lifting body, diesel tractor with two trolleys or ULD loader trips (pcs) during a day:

$$Z = \frac{T * V_v * k_{us.\,r} * K_{us.\,t}}{L_a + t_{dt} + V_v + k_{us.\,r}}, \qquad (2.27)$$

where T - is time of warehouse work, hours per day;

V_v - is average transportation speed of vehicle with lifting body, diesel tractor with two trolleys or ULD loader, correspondently, km/hour;

$k_{us.\,r}$ - is coefficient of running usage (it should be taken as 0.7-0.8);

L_a - is average distance from warehouse to the aircraft parking place, km;

t_{dt} - is duration of vehicle downtime under loading and unloading works during one working cycle, hours (it should be taken as 10 min, which is equal to 0.17 hour);

$K_{us.\,t}$ - is coefficient of vehicle usage during working time (it should be taken as 0.6).

$$Z_{diesel\ tractor} = \frac{T * V_{v\ (diesel\ tractor)} * k_{us.\,r} * K_{us.\,t}}{L_a + t_{dt} + V_{v\ (diesel\ tractor)} + k_{us.\,r}} = \frac{24 * 20 * 0{,}8 * 0{,}6}{2{,}1 + 0{,}17 + 20 + 0{,}8} =$$

$$= \frac{230{,}4}{22{,}35} = 10{,}3 \approx 11\ [\text{pieces}]$$

$$Z_{VLB} = \frac{T * V_{v\ (VLB)} * k_{us.\,r} * K_{us.\,t}}{L_a + t_{dt} + V_{v\ (VLB)} + k_{us.\,r}} = \frac{24 * 20 * 0{,}8 * 0{,}6}{2{,}1 + 0{,}17 + 20 + 0{,}8} \approx 11\ [\text{pieces}]$$

$$Z_{ULD\ loaders} = \frac{T * V_{v\ (ULD\ loaders)} * k_{us.\,r} * K_{us.\,t}}{L_a + t_{dt} + V_{v\ (ULD\ loaders)} + k_{us.\,r}} = \frac{24 * 30 * 0{,}8 * 0{,}6}{2{,}1 + 0{,}17 + 20 + 0{,}8} = 15{,}46 \approx 16\ [\text{pieces}]$$

Productivity of vehicle with lifting body, diesel tractor with two trolleys or ULD loader (t/hour):

$$P = Q * Z * K_{us.\,c}, \qquad (2.28)$$

where Q - is carrying capacity of vehicle with lifting body, diesel tractor with two trolleys or ULD loader, correspondently, t;

Z - is number of vehicle with lifting body, diesel tractor with two trolleys or ULD loader trips during a day, correspondently;

$K_{us.\,c}$ - is coefficient of carrying capacity usage by apron mechanized mean (it should be taken as 0.7-0.8).

$$P_{\text{diesel tractor}}=Q_{\text{diesel tractor}}*Z_{\text{diesel tractor}}*K_{us.\,c}=30*11*0,8=264\ [\frac{t}{h}]$$

$$P_{\text{VLB}}=Q_{\text{VLB}}*Z_{\text{VLB}}*K_{us.\,c}=5*11*0,8=44\ [\frac{t}{h}]$$

$$P_{\text{ULD loader}}=Q_{\text{ULD loaders}}*Z_{\text{ULD loaders}}*K_{us.\,c}=7*16*0,8=89,6\ [\frac{t}{h}]$$

Necessary number of vehicles with lifting body, diesel tractors with two trolleys and ULDs loaders (pcs):

$$N=\frac{Q_{day}*K_n}{P*K_{tr}}, \tag{2.29}$$

where K_{tr} – is coefficient of technical readiness of vehicle with lifting body, diesel tractor with two trolleys or ULD loader, correspondently (it should be taken as 0.7-0.8).

$$N_{\text{diesel truck}}^{\text{DAL}}=\frac{Q_{\text{total}}^{\text{DAL}}*K_n}{P_{\text{diesel tractor}}*K_{tr}}=\frac{48,44*1,5}{264*0,8}=0,34\approx1\ [\text{pieces}]$$

$$N_{\text{VLB}}^{\text{DAL}}=\frac{Q_{\text{total}}^{\text{DAL}}*K_n}{P_{\text{VLB}}*K_{tr}}=\frac{48,44*1,5}{44*0,8}=2.06\approx3\ [\text{pieces}]$$

$$N_{\text{ULD loader}}^{\text{DAL}}=\frac{Q_{\text{total}}^{\text{DAL}}*K_n}{P_{\text{ULD loaders}}*K_{tr}}=\frac{48,44*1,5}{89,6*0,8}=1,09\approx2\ [\text{pieces}]$$

$$N_{\text{diesel truck}}^{\text{IAL}} = \frac{Q_{\text{total}}^{\text{IAL}} * K_n}{P_{\text{diesel tractor}} * K_{tr}} = \frac{118,56*1,5}{264*0,8} = 0,84 \approx 1 \text{ [pieces]}$$

$$N_{\text{VLB}}^{\text{IAL}} = \frac{Q_{\text{total}}^{\text{IAL}} * K_n}{P_{\text{VLB}} * K_{tr}} = \frac{118,56*1,5}{44*0,8} = 5,47 \approx 6 \text{ [pieces]}$$

$$N_{\text{ULD loaders}}^{\text{IAL}} = \frac{Q_{\text{total}}^{\text{IAL}} * K_n}{P_{\text{ULD loaders}} * K_{tr}} = \frac{118,56*1,5}{89,6*0,8} = 2,48 \approx 3 \text{ [pieces]}$$

During the performance of this work, we considered volumes of cargo flow shares for DAL and IAL, which were divided into export, import and transit and classified as bulk or ULD. It was the starting point for determination of view of warehouses [20].

Taking into account good's flows of each, we determined load capacity of domestic and international warehouses [17].

Then defined necessary areas for processing cargo and zones for assistance. Considering working areas and given dimensions of stack for DAL and cells for IAL, we received relevant number of two above for satisfying demand for cargo accommodation. Than evaluated linear dimensions of building, using it we determined number of gates and length of loading/unloading front [18].

At final stage we obtained number of mechanized means but due to variety of production needs, we have a few types of vehicles, that operate inside of warehouse and out of it. Based on the above cargo traffic, we have carried out a justification of the technical characteristics of the cargo terminal.
which will handle 167 tons per day. According to the calculations, the number of equipment in the terminal for processing the corresponding volume of flows is as follows: 5 ULD loaders, 2 diesel tractors, 9 VLB vehicles.

Boryspil Airport plans to build a new cargo terminal for another 15,000 square meters that will handle export and import cargo, and then - to reconstruct old cargo warehouses (another 7-8 thousand square meters) and convert them into a specialized warehouse for perishable goods. Including that fact annual turnover

of both cargo terminals is expected 104194 tons after finish of a new cargo complex (see Fig. 2.7).
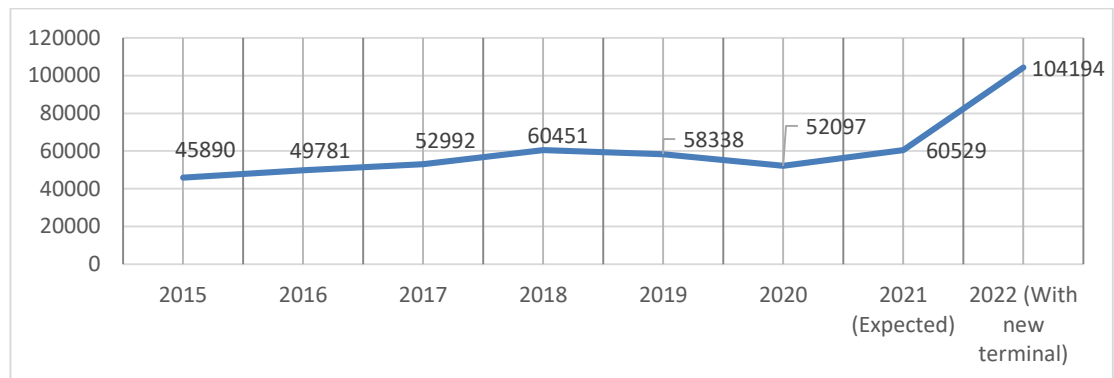
Fig. 2.7 Cargo turnover during 2015-2022 (tons). Including expected turnover in 2021 and 104194 tons in 2022 after completion of a new cargo terminal.

One of the main problem of cargo terminal it is worn-out infrastructure which hinder development of national air cargo carriage. Capacity of terminal remains unchanged for many years in result the terminal has problems with traffic especially in bad weather [19].

The second reason which hinder development it is lack of direct connections with popular destinations like: Los-Angeles, Heathrow, Frankfurt, Hong Kong, Shanghai, Beijing, Delhi. Direct access to this destinations will reduce transit time.

The third reason is the COVID-19 pandemic. Many flight reductions caused large expenditures for airlines.

Another problem is downtime during cargo handling, in order to reduce delays of issuance cargo from warehouses we can use ABC XYZ analysis. ABC XYZ analysis allows you to determine the demand for a product against the background of a varied range of goods that are placed in a temporary storage warehouse at the airport. This analysis is used to classify groups of goods, where the most popular groups should be placed closer to the exit from the warehouse, which reduces the time for their search and removal (see Table 2.2 and Table 2.3).

Table 2.2.

Statistics of cargo arrival (kg) to airport for 10 consignees

№	January	February	March	April	May	June	July	August	September	October	November	December
1	434	435	434	2332	542	532	754	2321	533	575	423	2142
2	232	5436	333	234	643	753	564	233	634	252	555	323
3	444	967	765	342	444	113	1346	463	434	2623	754	432
4	5678	764	444	677	533	754	764	344	532	432	685	486
5	343	677	578	646	112	431	753	633	767	222	457	453
6	665	633	555	975	754	523	231	634	231	422	658	864
7	456	432	876	342	325	756	342	342	765	655	667	435
8	843	124	666	432	843	425	745	386	885	155	679	965
9	1258	562	876	653	643	986	434	544	5848	987	352	3235
10	876	188	777	244	658	456	744	755	747	434	414	545

Table 2.3.

ABC analysis

ABC analisys

№	evenue ye	ealisation	№	e total am	f increasin	Group
1	11457	12,3402	9	17,6405	17,6405	A
2	10192	10,9777	4	13,0252	30,6657	A
3	9127	9,8306	1	12,3402	43,0059	A
4	12093	13,0252	2	10,9777	53,9836	A
5	6072	6,5401	3	9,8306	63,8142	A
6	7145	7,6958	8	7,6990	71,5132	A
7	6393	6,8858	6	7,6958	79,2090	A
8	7148	7,6990	10	7,3651	86,5741	B
9	16378	17,6405	7	6,8858	93,4599	B
10	6838	7,3651	5	6,5401	100	C
Total:	92843	100		100		

Consignees 1-7 is the most important , because they have the highest demand and require allocation of their goods near to the exit of warehouse . Consignees 8, 9 ensure stable cooperation, they are also important. C group is not main group of clients, their goods can be accommodated in remote places of warehouse.

Client 8 is characterized by a stable value of consumption and a high degree of forecasting with sales fluctuations from 5% to 15%.

Client 7, 10 and 6 they are characterized by seasonal fluctuations and the average possibility of their prediction with sales fluctuations from 15% to 50%. Clients that belong to Z-group with sales fluctuations of 50% or more, these are customers with irregular consumption and unpredictable fluctuations, therefore, it is impossible to predict their demand (see Table 2.4).

Table 2.4.

XYZ analysis

XYZ analisys										
№	1	2	3	4	varage valu	icient of varia	№	V	Group
1	1303	3406	3608	3140	2864,25	31,999371	8	8,103055	X
2	6001	1630	1431	1130	2548	78,552631	7	10,169187	Y
3	2176	899	2243	3809	2281,75	45,212933	10	21,269963	Y
4	6886	1964	1640	1603	3023,25	73,913076	6	23,796299	Y
5	1598	1189	2153	1132	1518	26,897766	5	26,897766	Z
6	1853	2252	1096	1944	1786,25	23,796299	1	31,999371	Z
7	1764	1423	1449	1757	1598,25	10,169187	9	43,913848	Z
8	1633	1700	2016	1799	1787	8,103055	3	45,212933	Z
9	2696	2282	6826	4574	4094,5	43,913848	4	73,913076	Z
10	1841	1358	2246	1393	1709,5	21,269963	2	78,552631	Z

AX involves consignee №8, it means stability, ensuring high rate of sales, it is very important to provide constant availability of goods. Consumption of goods is well predicted.

AY and BY mean not enough stability at high cargo turnover, for providing constant presence of products for clients, we need enlarge insurance stock.

AZ clients are characterized by low prediction, in order to avoiding excess goods, we must transfer part of the goods to the order system with a constant amount (volume) of the order; choose suppliers located close to the warehouse, thereby reducing the amount of insurance stock; entrust the most experienced manager of the company to work with this group of products.

CZ includes client №5, that characterized by spontaneous demand, goods for them are delivered by order (see Table 2.5 and 2.6).

Table 2.5.

Classification of cargo groups

ABC		XYZ		ABC-XYZ	
№	Group	№	Group	№	Group
1	A	1	Z	1	AZ
2	A	2	Z	2	AZ
3	A	3	Z	3	AZ
4	A	4	Z	4	AZ
5	C	5	Z	5	CZ
6	A	6	Y	6	AY
7	B	7	Y	7	BY
8	A	8	X	8	AX
9	A	9	Z	9	AZ
10	B	10	Y	10	BY

Table 2.6.

Result of ABC XYZ analysis

	X	Y	Z
A	8	6	1;2;3;4;9
B		7;10	
C			5

2.11 Experience of other cargo terminals

To simplify the customs document flow in the field of air cargo transportation, Shanghai Airport (see Fig. 2.8) has introduced the e-Freight standard. The implementation of the workflow standard was an IATA initiative. To implement this project, several agreements were signed between IATA, the Shanghai Customs Administration, the Shanghai Entry-Exit Inspection and Quarantine Office, the Airport Administration, China Eastern Airlines and the management of the Shanghai E-port portal.

Fig. 2.8 Shanghai airport

This standard eliminates paper-based document circulation of consignment notes and replaces them with an electronic version. The e-Freight standard increases the efficiency of service and optimizes the exchange of data between the parties to the agreement and reduces the cost of customs clearance of goods due to the abolition of paper permits for the release of goods.

China is currently the world's second largest air cargo market, so the implementation of international cargo handling standards is important both for shippers and for numerous industrial enterprises exporting their products abroad.

The e-Freight electronic document management standard is already being tested at Baiyun International Airport (Guangzhou) and Beijing Airport (PEK).

In June 2014, China Cargo Airlines already launched electronic filing of waybills for its cargo passing through Shanghai Pudong. Then the airport recorded an increase in cargo turnover by 8% and became the leader in this indicator among all Chinese international cargo terminals.

There are three cargo handling companies at Hong Kong airport (see Fig. 2.9): Hong Kong Airport Services Limited HAS, Jardine Air Terminal Services Limited and Menzies Aviation Group. These services handle cargo, mail and baggage. To handle passenger baggage, the airport has a BHS system located in the basement of the airport. At the moment, the airport handles about three million

tons per year. The airport has a 328,000 square meter terminal which is the second largest self-contained cargo terminal after the opening of the West Cargo Handling Area at Shanghai Pudong International Airport on March 26, 2008.

Fig. 2.9 Hong Kong airport

In 2017, Heathrow Airport (see Fig. 2.10) handled 1.7 million tons of cargo, an increase of 10.2 percent over the previous year. By destinations, the largest growth was driven by air travel from the United States, East Asia and Europe. Freight traffic increased especially significantly in December - the growth was 7.3%, while the greatest increase was shown by air transportation of goods from Hong Kong, Japan and the United States. This growth in freight traffic can be explained by the growing economy.

Fig. 2.10 Heathrow airport

By the end of the year, air cargo transportation at Gatwick Airport (see Fig. 2.11) increased by a third - by 33.6%. In 2017, the airport's cargo turnover amounted to 97,045 tons, last year 77,995 tons were handled. Gatwick Airport specializes in servicing low-cost air carriers and only a few years ago began to develop air cargo transportation.

Fig. 2.11 Gatwick airport

SUMMARY

Air Transportation Management Department				NAU.21.03.97 002EN				
Done by:	Ihor A. Tishyn				Letter		Sheet.	Sheets
Supervisor:	Iryna I. Vysotska			SUMMARY		D	66	1
Standards Inspector	Yuliia V. Shevchenko				FTML 275 ОП- 403Ба			
Head of the Department	Shevchuk D. O.							

Boryspil Airport is a member of the International Airports Association, the International Air Transport Association and the International Civil Aviation Organization. The airport also has a cargo terminal, which is one of the largest in Ukraine. Airport serves Ukrainian International Airlines, Windrose, Azur Air Ukraine, Turkish Airlines, Flydubai, KLM, Air France, Lufthansa, Austrian Airlines AG, Czech Airlines, LOT Polish Airlines, Yanair, Cyprus Airways, Swiss International Airlines AG, Ryanair, Laudamotion, EL AL Israel Airlines, Qatar Airways, Belavia, Air Baltic, Air Arabia, Air Astana, Georgian Airways, SkyUp. The airport has 2 runways, one of which is working another one is used but not regular.

Such elements like airlines and runways provide continuous flow of goods at cargo terminal. Last year, 52,097 tons of cargo was handled, based on this, on average per day, the terminal passes through itself 142.73 tons per day, while the design capacity is from 40 to 100 tons per day. Based on this, we can conclude that the terminal is overloaded almost 1,5 times because 142.73 / 100 = 1.42. Based on the international experience in the development of terminal complexes, it is possible to highlight the fact that the development of the airport will always be associated with the expansion of the airport territory. The introduction of new technologies to the terminal will also improve its operation, but this will not be a promising direction of development, because in the end the production area will remain unchanged. Examples of this are Shanghai International Airport, Hong Kong International Airport.

In the case of Boryspil airport, it is obvious that it needs expansion, the question remains how much it needs to be expanded. To do this, we need to make a forecast, in the work we used forecasting by the trend line method according to which in 2021 it is expected 59098 tons, and in 2022 it is expected 60931 tons. And according to the trend of the international transportation market and the globalization policy, the transportation of goods will increase every year, increasing the load on the airport. According to the calculations, we will design a new cargo terminal with a total area of 15,000 square meters. Based on the results

obtained, in order to ensure the throughput from 60,500 to 150,000 tons per year, we need another new warehouse with an area of 6200 square meters. We need 3 diesel tractors, 9 ULD transporters and 17 forklift tractors.

The new cargo terminal with an area equal to the area of the old cargo terminal will reduce the load on the infrastructure of the complex, separate cargo flows for mail and the rest. According to preliminary estimates, such a solution will increase the terminal's efficiency by another 100% with at least an expected annual cargo turnover of 100,000 tons in approximately 5-7 years.

Also from point of view of warehouse logistics it is relevant to use ABC XYZ analysis which determine which cargo have the most frequency of pick up and allocate them near exit of warehouse for reducing time for their pick up, this solution reduces time approximate on 5 minutes of cargo handling.

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