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Факультет аеронавігації, електроніки та телекомунікацій
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ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач кафедри АНС
д-р техн. наук, проф.
______________ Ларін В.Ю.
«____» ____________ 2023р.

ДИПЛОМНА РОБОТА
(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ «МАГІСТР»
за освітньо-професійною програмою
«ОБСЛУГОВУВАННЯ ПОВІТРЯНОГО РУХУ»

Тема:

ЗАТРИМКИ В НАЗЕМНОМУ ОБСЛУГОВУВАННІ ЛІТАКІВ У СИСТЕМІ УПРАВЛІННЯ ПОВІТРЯНОГО РУХУ

Виконавець: Олабина Юлія Іванівна

Керівник: Богуненко Микола Миколайович

Нормоконтролер Аргунов Геннадій Федорович

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НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

Факультет аеронавігації, електроніки та телекомунікацій

Кафедра аеронавігаційних систем

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ЗАТВЕРДЖУЮ

Завідувач кафедри АНС

_________________В.Ю. Ларін

«____»______________ 2023 р.

ЗАВДАННЯ

на виконання дипломної роботи

Олабиної Юлії Іванівни

1. *Тема дипломної роботи*: **«Затримки в наземному обслуговуванні літаків у системі управління повітряного руху»** від "22" серпня 2023 р. № 1443/ст

2. *Термін виконання роботи:* 23.10.2023 – 31.12.2023

3. *Вихідні дані до роботи:* керівні документи Міжнародної організації цивільної авіації та національні документи у сфері організації та здійснення польотів.

4. *Зміст пояснювальної записки:* збір та аналіз статистичних даних про затримки, аналіз способів передачі інформації та дій авіаційного персоналу, аналіз документів щодо організації роботи наземного обслуговування, створення потенційної моделі системи сповіщення, охорона праці та захист навколишнього середовища.

5. *Перелік обов'язкового графічного (ілюстративного) матеріалу:* графіки результатів даних, таблиці, формули, алгоритми, зображення обладнання.

6. Календарний план-графік

№ п/п	Завдання	Термін Виконання	Відмітка про виконання
1.	Підготовка та написання 1 розділу «Аналіз дій при виникненні затримок»	30.10.23-05.11.23	виконано
2.	Підготовка та написання 2 розділу «Дослідження специфіки наземного обслуговування повітряного судна»	06.11.23-12.11.23	виконано
3.	Підготовка та написання 3 розділу «Методи поширення та обміну інформацією»	13.11.23-19.11.23	виконано
4.	Підготовка та написання 4 розділу «Концептуальна модель системи передачі інформації між наземним агентом або компанією та диспетчером повітряного руху»	20.11.23-26.11.23	виконано
5.	Підготовка та написання 5 розділу «Охорона праці та охорона навколишнього середовища»	27.11.23-05.12.23	виконано
6.	Підготовка презентації та доповіді	06.12.23-31.12.23	виконано

7. Дата видачі завдання: «_23_ » _жовтня_ 2023 р.

Керівник дипломної роботи ___________ __Богуненко Микола Миколайович
(підпис керівника) (прізвище, ім'я, по батькові)

Завдання прийняла до виконання __________ Олабина Юлія Іванівна
(підпис студента) (прізвище, ім'я, по батькові)

РЕФЕРАТ

Пояснювальна записка до дипломної роботи «Затримки в наземному обслуговуванні літаків у системі управління повітряного руху»: 95 сторінок, 25 рисунків, 9 таблиць, 21 використане джерело.

Об'єкт розробки – Система управління повітряним рухом.

Предмет розробки – Координація між службою наземного обслуговування та диспетчером.

Мета роботи – розробка напрямів удосконалення технологій функціонування наземних служб для перешкоджання збійних ситуацій в аеропорту та на аеродромах.

Методи дослідження – метод системного аналізу даних,статистичних досліджень, метод групування, аналізу та порівнання документів з організації наземної підготовки авіакомпаній, метод математичного моделювання процесів обслуговування.

В роботі були розглянуті основні причини затримок які виникають під час наземного обслуговування, їх вплив на розклад польотів, можливі наслідки для пасажирів та авіакомпаній. Детально досліджено способи їх усунення, щоб надавати послуги більш ефективно. В роботі проаналізовано існуючих проблем, досліджувалися сучасні підходи до систем сповіщення. Результатом дослідження стала розробка ефективної системи оповіщення та оперативного інформування зацікавлених осіб про поточний стан підготовки літака до польотів.

УПРАВЛІННЯ ПОВІТРЯНИМ РУХОМ, ПОВІДОМЛЕННЯ ПРО ЗАТРИМКИ, ЕФЕКТИВНІСТЬ, ПОВІТРЯНЕ СУДНО, ОБСЛУГОВУВАННЯ, КООРДИНАЦІЯ, НАЗЕМНА ПІДГОТОВКА

АРКУШ ЗАУВАЖЕНЬ

MINISTRY OF EDUCATION AND SCIENCE, OF UKRAINE
NATIONAL AVIATION UNIVERSITY
Faculty of Air navigation, Electronics and Telecommunication
Air Navigation System Department

PERMISSION TO DEFEND
GRANTED
Head of the Department
___________V.Yu. Larin
“__”_____________2023

MASTER’S DEGREE THESIS

Theme:

“Delays in ground handling service of aircrafts in air traffic control system”

Completed by: Olabyna Y.I.
Supervisor: Bogunenko M.M.

Standarts Inspector: Arhunov H.F.

Kyiv 2023

NATIONAL AVIATION UNIVERSITY

Faculty of Air navigation, Electronics and Telecommunication

Air Navigation Systems Department

Specialty: 272 “Aviation transport”

APPROVED BY

Head of the Department

_____________ V.Yu. Larin

“__”_____________ ______2023

Graduate Student’s Degree Thesis Assignment

Yuliia Olabyna

1. *Mather thesis topic:* “Delays in ground handling service of aircrafts in air traffic control system” approved by the Rector’s order of 23.10.2023 № 1443/st.

2. *The Project to be completed between:* 23.10.2023 – 31.12.2023.

3. *Initial data to the project:* the guiding documents of the International Civil Aviation Organization and national documents in the field of organizing and conducting flights.

4. *The content of the explanatory note (the list of problems to be considered):* collection and analysis of statistical data on delays, analysis of methods of information transmission and actions of aviation personnel, analysis of documents related to the organization of ground handling work, creation of a potential model of the notification system, labor precaution and environmental protection.

5. *The list of mandatory graphic (illustrated) materials:* graphs of results data, tables, formulas, algorithms, images of equipment.

6. Calendar timetable

№	Completion stages of Degree Project	Stage completion dates	Remarks
1	Preparation of chapter 1: “Analysis of the actions in the occurrence of delays”	30.10.23-05.11.23	completed
2	Preparation of chapter 2: “Studying the specific of ground handling in aviation”	06.11.23-12.11.23	completed
3	Preparation of chapter 3: “Methods of information distribution and exchange”	13.11.23-19.11.23	completed
4	Preparation of chapter 4: “Conceptual model of the system for information transmission between the ground handling agent or company and the air traffic controller”	20.11.23-26.11.23	completed
5	Preparation of chapter 5: “Labor precaution and environment safety”	27.11.23-05.12.23	completed
6	Preparation of report and graphic materials	06.12.23-31.12.23	completed

7. Assignment accepted for completion “23” October 2023

Supervisor____M.M. Bogunenko

Assignment accepted for completion ___________________________Y.I. Olabyna

ABSTRACT

Explanatory note to the diploma work "Delays in ground handling service of aircrafts in air traffic control system": 17 figures, 9 tables, 8 block diagrams, 1 appendix, 21 used sources.

Aim of the work: development of areas for improving the technology of ground services to prevent disruptions at the airport and airfields.

Object of the work: Air traffic control system.

Subject of the work: Coordination between handling service and air traffic control officer

Research methods: Method of systematic data analysis, statistical research, a method of grouping, analyzing and comparing documents on the organization of airline ground handling, a method of mathematical modeling of service processes.

AIR TRAFFIC CONTROL, DELAY REPORTING, EFFICIENCY, AIRCRAFT, SERVICES, COORDINATION, GROUND HANDLING

The thesis contain main causes of delays that occur during ground handling, their impact on flight schedules, and possible consequences for passengers and airlines. The ways to eliminate them in order to provide services more efficiently are studied in detail. The paper analyzes the existing problems and study modern approaches to notification systems. The result of the research was the development of an effective warning system and prompt informing of involved parties about the current state of aircraft preparation for flights.

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LIST OF ABBREVIATIONS

ACC – Area Control Center

AD – Aerodrome

ANSPS – Enhanced Tactical Flow Management System

ATCO – Air Traffic Control Officer

ATC – Air Traffic Control

ATM – Air Traffic Management

ATS – Air Traffic Service

CTMO – Centralized Traffic Management Organization

DLA – Delay

EUROCONTROL – The European Organization for the Safety of Air Navigation

FLP – Flight plan

FMD – Flow Management Division

GND – Ground

GPU – Ground Power Unit

ICAO – International Civil Aviation Organization

PAX – Passenger(-s)

INTRODUCTION

Airplane delays are a serious problem in modern air traffic system. Constantly growing number of users airspace increases the capacity of airport facilities and route networks, which in turn leads to a sharp increase load on all flight support systems and increase the risk of errors (or deviations) of calculations/preliminaries. Flight delays are the result significant costs for air traffic control bodies and additional fees from airline, which considers the cost of the ticket. During ground handling service there are a lot of delays occurs due to untimely arrival of pax, baggage, cargo, fuel truck, toilet service, catering service, anti-\de- icing service and other. Aircraft preparation – is the main source of ground delays.

Modern aircrafts spent approximately 30-40 minutes on ground, this helps to arrange quick turnaround, increase number of flights and profit. It is important to find out the main sources of delay and the way how to improve it to provide services more effective. Delays during ground handling can impact departure schedules, causing disruptions in flight schedules and negative consequences for passengers and airlines. Therefore, the development of an effective notification system is a significant task for the aviation sector. Ehe ramp operating environment poses numerous unique safety and sustainability considerations as well amidst time pressures. Evaluation of current protocols and infrastructure coupled with emerging technologies spotlights room for gains on both fronts alongside operational enhancements. Proposed conceptual improvements to holistic information transmission target more predictive, reliable ground handling to drive airport capacity, costs and customer service as markets continue expanding.

To achieve the goal, we need to solve and analyze the following questions. Statistical information about delays to find out the main sources and compare European and American traffic. This paper analyzes current procedures and interactions between ground handlers, air traffic control, and flight crews during regular operations and delays. Different information transmission types, accuracy, speed, traceability and standardization. Quantifying expert perspectives shapes a conceptual system for unified, digital information flows aimed at more transparent, efficient ground handling.

The analysis examines ground time optimization methods involving slots, equipment, personnel, and workflow innovations while considering emerging technologies. Safety and environmental facets of existing ramp operations receive scrutiny along with recent improvements.

Overall, this review spotlights opportunities around ground process digitization, automation and integrated data utilization to better manage turnaround variability. The conceptual improvements target more predictive, reliable ground handling via systemwide information sharing to ultimately benefit airport capacity, costs and customer service as aviation services continue expanding.

To achieve the goal of the diploma work, the following **tasks** must be solved:

- To study the main causes of delay
- Alanyse the methods of solvig this problem, current procedures and interactions between ground handlers, air traffic control, and flight crews during regular operations and delays.
- Creating a model of notification system
- Writing chapter «Labor Precaution and environmental safety»
- Made calculation in Special chapter

CHAPTER 1. ANALYSIS OF THE ACTIONS IN THE OCCURRENCE OF DELAYS

1.1 Statistic of the most common delays

A flight delay is the absence or deviation from the scheduled time of departure or arrival. Delays can be caused by various reasons, such as technical malfunctions of the aircraft (aircraft), unforeseen weather conditions, problems at the airport or airspace, as well as organizational or operational issues. Flight delays can affect passengers' travel schedules and lead to unexpected changes in plans. Airlines and airports regularly take measures to minimize delays and ensure optimal organization of air traffic.

The constantly growing number of airspace users increases the capacity of airport facilities and the route network, which in turn leads to a sharp increase in the load on all flight support systems and an increase in the risk of errors (or deviations) of calculations/predictions. Flight delays are the result of significant costs of air traffic control (ATC) and additional commissions from the airline, which takes into account the cost of the ticket.

Delays can be used as a numerical indicator of air transport efficiency. For example, in Eurocontrol airspace, the average arrival delay time for 2020 is 12.4 minutes.

The main causes of delays can be grouped by source of origin:

a) Airline - includes delays caused by the handling served passengers and baggage; cargo loading; maintenance of runways and ramps; technical problems and adjustments of aircraft equipment; aircraft damage; flight performance and crew reliability.

b) Airport - contains delays caused by airport equipment; restrictions at destination and departure airports.

c) On the route - air traffic flow management due to the requirements of the air traffic control on the route; ATC personnel and ATFM equipment.

d) Governmental, including security and immigration delays.

e) Weather conditions, dangerous weather phenomena.

f) Reactivity - the result of untimely arrival of aircraft, pax, cargo or crew.

g) Others.

Let's review statistics and reasons for delays by continent.

It's been a chaotic year for airlines in the United States, with more than 22% of all flights suffering delays or cancellations, and some carriers having even more problems. According to Bureau of Transportation statistics [1] reviewed by Travel + Leisure , the 10 major U.S. airlines collectively achieved 76.78% on-time performance from October 2021 to August 2023. The problems included everything from delays due to airlines to problems due to weather, delayed planes, etc. (Figure 1.1).

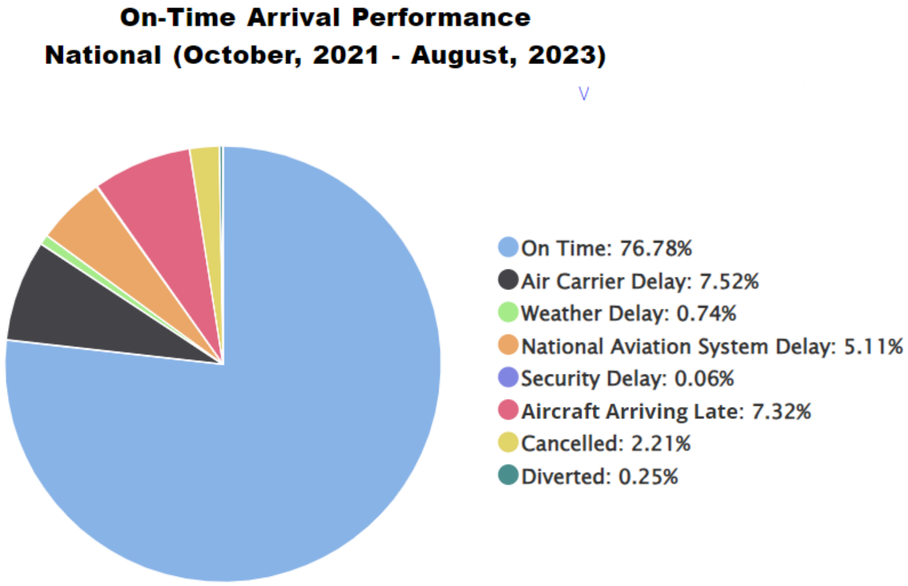

Figure 1.1 – Statistics of on-time flight arrivals and delays

Air carriers were responsible for 7.83% of all delays last year. According to [2] Allegiant Air had the lowest on-time percentage of all 10 major airlines, being on time only 61.96% of the time from July 2021 to July 2022. Allegiant's delays and cancellations, 8.45% were caused by an airline delay, and 4.34% were caused by flight cancellations or diversions.

An Allegiant representative pointed to high demand and understaffing, in addition to external factors such as weather, as reasons for the delays.

"As an airline that is 100% focused on leisure travel, we take care of the needs of our customers and understand how frustrating it can be when a flight is delayed," said a T+L spokesperson. "We are actively working to mitigate labor shortages by offering additional incentives to attract and retain key employees, including higher salary, bonuses, flexible work hours and more."

Allegiant is followed by JetBlue, which had an on-time rate of 65.57% over the same period [3]. In total, 13.47% of JetBlue's problems were related to the carrier's delay. A JetBlue spokesperson pointed to the carrier's multiple flights in the "congested Northeast Corridor, familiar with weather conditions," which they said contributed to the delays.

"We know delays are never ideal, but with most of our customers traveling on holiday or visiting family and friends, we do everything we can to avoid flight cancellations and get customers where they need to go, which speaks volumes for our greater efficiency. factor," Derek Dombrowski, general manager of corporate communications for JetBlue, T+L [4].

On the other end of the spectrum was Hawaiian Airlines, which had the highest on-time percentage of any major US airline at 85.43%. Only 0.83% of Hawaiian flights were canceled or diverted [4]. It is followed by Delta Air lines, which showed an on-time percentage of 83.32%.

Although we saw massive flight cancellations and reductions in schedules over the summer to minimize disruption, the situation has improved since then. But the winter holiday season can still bring a lot of problems, Alice Mariscotti-Wyatt, head of content at AirHelp, told T+L [4].

"It's likely that we could see [an increase in] cancellations and delays as we get more flight volume again," Mariscotti-Wyatt said. "What we see in the data is that typically in any case where you have a higher volume of flights, you typically see an increase in disruptions, and that was also true before the pandemic."

Mariscotti-Wyatt said there are a few things travelers can do to avoid problems, such as booking a flight before noon and flying on a Tuesday or Wednesday, when fewer flights are in the air. In fact, according to AirHelp, Tuesday was the second slowest day of the week with an average of just over 849,000 flights per day from

January to October. At the same time, Tuesday had the fewest canceled flights - only 1.54%.

But disruptions inevitably happen, and Mariscotti-Wyatt said the most important thing is to know your options when they do. In September, the Department of Transportation launched a new website detailing airlines compensation policy, and the agency proposed a rule change that would require airline to provide refunds for domestic flight delays.

These are the on-time percentages for all 10 major airlines from July 2021 to July 2022, according to the Transportation Bureau.

1. Alaska Airlines: 78.1%
2. Allegiant Air: 61.96%
3. American Airlines: 76.39%
4. Delta Air Lines: 83.32%
5. Frontier Airlines: 69.27%
6. Hawaiian Airlines: 85.43%
7. JetBlue: 65.57%
8. Southwest Airlines: 72.68%
9. Spirit Airlines: 71.83%
10. United Airlines: 78.04% [4].

Now let's review some European airlines.

The number of flight delays in the countries of the European Union (EU) has increased by more than 400% compared to previous years, according to Airlines for Europe (A4E), the largest association of EU airlines, which accounts for 70% of European air transport.

Average EU flight delays have increased by more than 400% as Europe's airspace capacity fails to keep up with demand, it said in a statement.

“The gap between the demand for airlines and the airspace capacity of Europe risks not being reduced at all, as the EU failed to provide adequate airspace capacity,” the association warns [5].

The warning comes after the publication of the latest annual report of the Single European Sky Performance Review Body (PRB). The report presents the results of the monitoring of air navigation services of the Single European Sky. According to the report, the average departure delay for various reasons was 19.03 minutes per flight.

The main reason for the delays was insufficient capacity of air traffic control, weather and other reasons. The war in Ukraine also had a detrimental effect, the report says. The average departure delay for various reasons was 19.03 minutes per flight.

In addition to airport capacity issues, Air Navigation Service Providers (ANSPs) were found unprepared to resume traffic, while others were affected by network disruptions. The impact of the war in Ukraine also had a detrimental effect.

Also, restrictions due to COVID-19 are returning to the field of travel. For example, at Gatwick Airport (London), flights are reduced due to an outbreak of illness among the staff [6].

Meanwhile, Ben Gurion Airport in Tel Aviv continues to operate, despite the military situation in the country. Flights are operated by all Israeli and some international airlines.

Thus, it can be noted that during the ground service of aircraft, the airport is faced with the everyday problem of air transportation - flight delay.

Flight delays have certain reasons, which include: adverse weather conditions, technical malfunctions of the aircraft, unforeseen circumstances, due to the fault of the airline or the airport. Each flight is performed at the time allocated to it according to the schedule and slot provided for this flight. A slot is a time of departure or arrival for a specific type of aircraft on a specific date in the airport schedule. Daily flight schedule or plan (DFP) — the entire list of flights departing and arriving at the airport per day.

The research of the reasons for the disruption of flights at the airport shows that the factors that form a given level of regularity of flights can be demonstrated as four groups, which are composed according to the following characteristics:

a) technical,

b) technological,

c) resource,

d) organizational.

Technical factors consist of the capabilities of the radio navigation systems of the airport airfield and the technical capabilities of the aircraft training production base.

Technological factors demonstrate the level of development of aircraft ground training technologies to ensure the safety and regularity of flights.

Resource factors characterize the resource capabilities of the airport to ensure the required level of regularity of flights.

Organizational factors that determine the appropriateness of the organizational structure of the airport, its divisions and services involved in the ground handling of air transportation, the management system for the execution of a given volume of transportation, the intensity of flights and the efficiency of using available resources [7].

Flight delays lead to additional costs, mainly for crew, fuel, aircraft and maintenance. Flight delays cost airlines $8.3 billion in 2007, according to a recently completed comprehensive flight delay study by the National Center for Excellence in Aviation Operations Research (NEXTOR). For passengers, additional travel time due to flight delays results in lost business productivity and lvacation opportunities. Based on estimates of passenger time lost due to schedule connected flight delays, flight cancellations and missed connections, NEXTOR estimated passenger costs at $16.7 billion in 2007.

To obtain information about the financial impact of flight delays, we studied the work of American scientists [26], who to determine the economic consequences of flight delays for the US economy, including direct consequences caused by technical changes in the air transportation industry, indirect consequences for industries that rely on air transportation for their business travel or depend on tourism and the opportunity cost of time for tourists. To capture these direct and indirect effects, a version of the USAGE applied general equilibrium (AGE) model (USITC, 2009) that includes flight delay is proposed. Based on available flight delay data, we define flight delay in our model as the percentage of flights that arrived (or departed) at a departure 15 minutes or more after the scheduled arrival (departure) time.

1.2 Concept of ground handling operational procedures and communication between all staff

The concept of ground handling procedures implemented as a list of works and operations for post-flight services and preparation for aircraft departure. Ground handling procedures are aimed at improving the quality of flight service and are used to ensure safety, timely maintenance of aircraft, and compliance with the requirements of regulatory acts regulating standards and norms for ground handling of aircraft at operating airports. If the service company has its own ground handling standard procedures, before entering into a ground handling contract, these standards are reviewed for compliance and approved as part of a preliminary audit.

Ground service of the aircraft starts from the moment the aircraft is placed on the operational stand for the purpose of preparing it for departure and ends with the departure of the aircraft or movement which is related to the departure.

Procedures for performing work during ground handling include:

a) Service at the parking stand:

1) Meeting and releasing the aircraft;
2) Establishing communication with the crew;
3) Grounding the aircraft;
4) Ensuring the aircraft's power supply from a ground source;
5) Air conditioning in the cabin using a ground source;
6) Heating of aircraft engines and aircraft systems (in cold weather conditions);
7) Opening/closing cargo hatches;
8) Starting aircraft engines using an air support unit;
9) Visual control of starting engines;
10) Aircraft towing;
11) External inspection of the aircraft.

b) Aircraft maintenance:

1) Maintenance of the drinking\potable water system;
2) Toilet system maintenance;
3) Refueling and draining fuel.

c) Anti- and de-icing.

d) Disinsection treatment.

The service company must ensure that only qualified and authorized personnel, who have passed the appropriate theoretical and practical training and training in accordance with established local regulations, will be allowed to perform the specified work and operate the equipment.

During ground handling of the aircraft, only serviceable equipment that corresponced regular maintenance and is appropriate for the type of aircraft should be used. Moreover, for each auxiliary equipment, means of mechanization used in the process of ground maintenance, a mandatory record of planned preventive and regulatory work is kept to maintain it in good condition, in accordance with the procedure established by the maintenance company.

The service company must ensure that all divisions participating in the execution of ground maintenance and its provision are equipped with all necessary types of communication, their workplaces are equipped with modern software, take into account the specifics of the division's activities. All employees must be provided with special clothing according to their type of activity, including personal protective equipment.

The specialist who performs this work is responsible for the quality and safety of aircraft ground handling procedures. Control over the quality of ground handling in general on the part of the service company must be carried out by an appointed responsible specialist who has the necessary training and skills, on the part of the airline - by an employee who performs representative functions at the airport, or in his absence by the flight crew [8].

As mentioned in chapter 1.1 of our work, one of the factors of flight delays is the organizational factor, which is determined by the coordinated work of all services for the organization and maintenance of flights. Let's consider in more detail the peculiarities of the interaction of airport services during the organization of flights, whether passenger or cargo transportation.

The structure of the transportation organization service is determined in each specific case, based on the volume of air transportation of this airport, the presence of an airport in this city, where the registration of departing passengers is carried out, the type of aircraft operating at this airport, the presence at the airport of international sector and other features of this airport. At large airports, with significant volumes of transportation, the transportation organization service consists of several independent services: passenger transportation organization service, mail and cargo transportation organization service, international transportation organization service. Other airport services include: aviation and technical base, Air Traffic Management Service, aviation security service, flight dispatch service, flight attendant service, ground facilities service, airfield service, fuel service, headquarters. The activities of all airport services are controlled by production and dispatching service of the enterprise.

Operational interaction of units and groups with other services of the airport has as its main goal to ensure the implementation of technological network schedules for timely and commercial service of aircraft in order to perform such tasks as:

a) ensure a high level of regularity and safety of flights;

b) carry out operational control of the timely execution of all technological operations;

c) ensure clear interaction of all groups and relevant airport services in the event of flight delays and "failures";

d) carry out timely dispatch of transit and transfer passengers;

e) increasing the economic efficiency of flights with maximum paid commercial loading of each flight.

The practice of CA work shows that interaction tasks are successfully solved using the dispatching management and control system, i.e., dispatching in which each group is responsible for performing one or another operation and the dispatcher has the authority to demand the execution of operations within the time limits set by the schedules. Implementation of dispatching allows:

a) to improve the organization and management of air transportation at the airport;

b) quickly eliminate malfunctions, failures and delays that occur during work;

c) monitor the progress of the technological process;

d) implement computer systems with the installation of terminals at dispatchers' workplaces.

During the ground handling of each flight, one of the necessary conditions for the good performance of all assigned tasks is the communication of all ground handling agents and groups with each other.

In case of flight delays, effective communication between the ATCO and ground handling agents is important to successfully deal with the problem/difficult situation and provide quality passenger service. Here are some recommendations:

a) Quick and clear communication - providing prompt and clear communication about the reasons for delays. It is important that the Tower and agents receive information immediately and understand the situation.

b) Exchange of information - implementation of constant exchange of information. This helps everyone to be aware about current situation and react to changes in real time.

c) Coordination of actions - coordination of actions for optimal management of the situation. Clear delineation of workload and responsibilities for each party.

d) Information for passengers - information service for passengers. Ground handling agents can provide up-to-date information and assist passengers in resolving inconveniences.

e) Understanding the reasons - dispatchers and agents should mutually understand the reasons for delays and take them into account when making decisions.

f) Contingency planning – develop action plans in advance for delays, including alternate routes, crew replacements, etc.

g) Effective problem solving - problem solving should be effective and aimed at the maximum reduction of delays.

h) Constant communication - maintaining constant communication to track the status of various processes.

i) Training and development - conducting training for agents and dispatchers on effective communication and problem solving.

j) Feedback exchange - after the occurrence of an event, exchange feedback to identify opportunities for improving delay management processes.

Effective communication and collaboration are key elements to a successful outcome and ensure passenger travel satisfaction.

1.3 Conducting radiotelephone communication in case of delay

Nowadays, the aviation industry plays a key role in providing efficient and fast means of transportation. However, in the process of operating airlines, various problems can arise, such as delays or potential delays of flights. An important part of managing such situations is the establishment of effective radiotelephone communication between the various participants in the aviation process.

Radiotelephone communication in aviation is not only a means of communication, but also a key element of safety and efficiency. The distinction of a high level of safety and the speed of decision-making depends on the quality and efficiency of communication between ait traffic control services, the crew and ground handling.

Rules for conducting radiotelephone communication are established standard procedures for communication between pilots, air traffic services and other ground personnel. To conduct radio communication, personnel must use standard Russian and English phraseology in the cases provided for in these Rules to provide appropriate instructions, permissions, recommendations, information, etc.

Flight delays can occur for a variety of reasons, including technical problems, weather conditions, or problems at airports. Potential delays can be anticipated and managed in advance, or they can occur due to unexpected circumstances.

Effective radiotelephone communication is critical in managing delay situations. Air traffic controller and ground handling agents must maintain constant communication to share information regarding the causes of delays, action plans and backup options. For the effective use of radiotelephone communication in conditions of delays, it is important to establish standardized protocols. Clear and concise messages, standard phrases and frequency ranges help avoid misunderstandings and ensure effective communication.

In [9], the requirements for the rules of conducting radiotelephone communication are given.

To prevent unnecessary delays during communication every notice prepared in writing should read before starting the transmission. The transmission is conducted in a concise form, in an ordinary conversational tone using standard phraseology.

During radio transmission, it is necessary ensure clear and satisfactory reception of messages. For the achievement of this goal by the aircrew of the aircraft, the air defense authority or other appropriate ground staff must:

a) pronounce each word clearly and clearly;

b) maintain a speed of speech, which would not exceed 100 words per minute. If the message transmitted on board the aircraft needs to be recorded, the speech rate needs to be lowered in order to this message could be recorded. A short pause before or after numbers makes it easier to understand them;

c) keep the volume of speech at a constant level;

d)know the technique of using a microphone, especially in relation to maintaining a constant distance to the microphone, if not a modulator with a constant level is used;

e) temporarily stop the conversation when necessary to turn away from the microphone.

After calling to aeronautical station,which receive message, we need to wait at least 10 seconds before the next call will be executed. This is necessary for prevention unnecessary transmissions while the station is preparing answer the previous call.

To transmit messages, you must use plain language or standard phrases without changing the content of the message. Abbreviations contained in the text of the message must be converted in full words and phrases, except for those that are understandable for aviation personnel.

Flight delays can occur for a variety of reasons, including technical problems, weather conditions, or problems at airports. Potential delays can be anticipated and managed in advance, or they can occur due to unexpected circumstances.

Effective radiotelephone communication is critical in managing delay situations. Air traffic controller and ground handling agents must maintain constant communication to share information regarding the causes of delays, action plans and backup options. For the effective use of radiotelephone communication in conditions of delays, it is important to establish standardized protocols. Clear and concise messages, standard phrases and frequency ranges help avoid misunderstandings and ensure effective communication.

It should not to speed up/accelerate your speech during the transmission of messages using words of the radiotelephone alphabet. When sending long messages, you must do short stops in order to make sure that the frequency at which transmission is in progress, not busy, and enable the station operator, that receives such messages, if necessary, make a request to repeating unaccepted parts of the message.

When conducting radiotelephone communication, they are used
standard words and phrases [10].

Establishing effective radiotelephone communication during the occurrence of delays or potential delays is key to successfully managing the situation and ensuring the safety and comfort of passengers at any airport in the world.

Here are some recommendations for establishing such connection:

a) Effectiveness of communication channels - ensure the availability of efficient and reliable radiotelephone communication channels that can be used by both dispatchers and ground handling agents.

b) Equipping personnel - ensure that personnel responsible for coordinating and managing the situation are properly equipped and trained to use radiotelephony effectively.

c) Protocol Standardization - Agree on standardized communication protocols to avoid misunderstandings and improve overall communication efficiency.

d) Clear and concise messages - provide clear and concise messages to avoid misunderstandings and ensure rapid information exchange.

e) Frequency bands - identify and use frequency bands designed for effective interoperation with other services at the aerodrome and in the airspace.

f) Scheduling Work Channels - Anticipate work channels for specific situations, including delay management.

g) Staff training - regularly train staff on the use of radiotelephone communication and effective communication in stressful situations.

h) Provision of backup - to have backup means of communication in case of possible failures or other technical problems.

i) Emergency Protocols - Develop emergency and accident protocols that require specific communication and interaction.

Given recommendations were created on the basis of a study of such documents as Appendix 10 "Aviation Telecommunications" [9], Aviation Rules of Ukraine "Air Traffic Services" [10].

CONCLUSION TO CHAPTER 1

The statistics of the most common delays show that air traffic delays are a significant factor in modern aviation. Delays can occur for various reasons, such as weather conditions, technical problems, airspace restrictions, etc. The analysis of these statistics allows identifying the main problematic aspects and developing strategies for their avoidance or reduction.

In the face of delays, effective communication between the dispatcher and ground handling agents is critical. Recommendations include clear and specific communication, mutual understanding of the situation and offering quick solutions to minimize delays. The use of advanced communication technologies can also improve the efficiency of information exchange.

Establishing radio-telephone communication in cases of delays is an important practice for prompt exchange of information and coordination of actions. This ensures immediate contact between the dispatcher and agents, allowing for quick response to situations and problem solving, which can help reduce delays.

Together, these aspects form a comprehensive approach to managing and reducing air traffic delays, improving the safety and efficiency of aviation operations.

CHAPTER 2. STUDYING THE SPECIFIC OF GROUND HANDLING IN AVIATION

2.1 Analys of time management for aircraft on ground

Ground service of the aircraft starts from the moment the aircraft is placed on the operational stand for the purpose of preparing it for departure and ends with the departure of the aircraft or movement which is related to the departure.

Procedures for performing work during ground handling include:

a) Service at the parking stand

1) Meeting and releasing the aircraft;
2) Establishing communication with the crew;
3) Grounding the aircraft;
4) Ensuring the aircraft's power supply from a ground source;
5) Air conditioning in the cabin using a ground source;
6) Heating of aircraft engines and aircraft systems (in cold weather conditions);
7) Opening/closing cargo hatches;
8) Starting aircraft engines using an air support unit;
9) Visual control of starting engines;
10) Aircraft towing;
11) External inspection of the aircraft.

b) Aircraft maintenance

1) Maintenance of the drinking\potable water system;
2) Toilet system maintenance;
3) Refueling and draining fuel.

c) Anti- and de-icing.

d) Disinsection treatment.

Aircraft ground maintenance is a set of works for receiving an aircraft at the parking lot, preparing for departure and releasing it into flight and consists of the following stages:

a) a meeting;

b) towing;

c) provision of ground power supply;

d) cabin air conditioning;

e) unloading and loading baggage;

f) refueling;

g) salon cleaning;

h) provision of on-board catering;

i) anti-icing;

j) engine start;

k) release.

Meeting - works from the meeting of the aircraft include its control with the help of visual signals during taxiing within the parking area, installation of pads, post-flight inspection of the aircraft.

Towing is necessary when the space of the airfield is limited, which makes it impossible to taxi the aircraft under the traction of its own engines, as well as for its movement without the participation of the crew during maintenance work.

Provision of ground power supply - to reduce the usage of APU and save fuel, the power supply of aircraft systems in the parking lot is usually carried out from a ground source. Most aircraft now use three-phase electric current with a phase voltage of 115 V and a frequency of 400 Hz. Some types use a constant voltage of 28 V. The example of ground power unit below (Figure 2.1). Ground power units are mobile equipment used to provide electrical power to aircraft while they are parked at the gate between flights. There are two types of connection, first one is power cable from GPU connects via large plug to a socket outlet on the aircraft exterior. Location varies by aircraft type. Second - provides alternate power option so aircraft engines or APU do not need to be running. Types of GPUs are fixed/stationary units mounted at terminal gates, which connects automatically, and mobile diesel or electric GPUs towed to remote stands without fixed power.

During the turnaround process between flights, attaching safe and reliable mobile or fixed ground power allows aircraft critical systems to remain powered up without having to run power-hungry jet engines or the auxiliary power unit. This provides preconditioned air and electricity while saving substantial fuel for airlines and cutting airport emissions from idle aircraft.

Figure 2.1 – Ground power unit

Refueling - for departure, the plane is refueled with fresh water and fuel. Filling can also include emptying the contents of the reception tanks of toilet systems. We can see on the picture (Figure 2.2) the example of fuel truck on apron. Refuelers (fuel trucks) pump and carry jet fuel to aircraft. Some have hydraulic booms to reach fuel access points. Ground staff use fueling panels near tanks or gear to monitor levels. Fueling vehicle connects to fuel port, typically in the aircraft wing. Fuelers open valves and pumping begins, observed by the flight crew via fuel gauge. Rate is managed to avoid aircraft balance or structural issues. Fuelers monitor gallons (liters) delivered.

Efficient, safe refueling operations are a vital dance between fuel crews on the ground and pilots observing from the cockpit. Clear communication, proper bonding, adherence to procedure prevents mistakes like overfuels, spills or fires - enabling an on time, incident free turnaround process.

Figure 2.2 – Fuel truck

Depending on the design of the aircraft, it may be necessary to fill the toilet system with a special liquid. Refueling with other liquids (oils, fluids for hydraulic systems) and gases (for example, oxygen) belong to aircraft.

Cabin air conditioning is provided from a ground source to reduce fuel consumption and reduce the load on aircraft systems. In cold season heated air is supplied, and in hot- cooled air is provided.

Air is supplied to the aircraft air conditioning system by means of a sleeve (a thin-walled hose of large diameter) through a quick-removable connection in the air conditioning system of the aircraft, usually closed by a hatch in the skin.

Cabin cleaning - is carried out to remove garbage and dirt from the passenger compartment and prepare for the meeting with passengers. Usually includes removing the contents of garbage cans, cleaning dirty seat covers and seat belts of passengers and crew, cleaning garbage with a vacuum cleaner and wet wiping interior elements of the cabin (window glass, mirrors, armrests, luggage shelves and their covers). The amount of cleaning depends on the form of maintenance of the aircraft and the time allowed for cleaning. It can be deep cleaning as snows below picture (Figure 2.3). It can also be fully or partially carried out with the help of the aircraft crew (usually cabin crew - flight attendants) to reduce aircraft parking time and airline costs.

Figure 2.3 – Deep cleaning of aircraft

Also, if there are enough time, cleaning company can use special truck (Figure 2.4) for collecting all equipment, such as vacuum cleaner etc. for deep cleaning. Trash and used items are cleared first by hand or with vacuums. Surfaces are wiped down with disinfectant solutions. Lavatories fully sanitized. Carpets vacuumed, seat pockets checked, tray tables cleaned. Blankets and pillows are replaced, safety cards/magazines restocked.

Tools: motorized vacuums to cover large floor areas rapidly, telescoping tools enable cleaning of overhead bins. Moveable carts full of replenished supplies like headphones, sanitizing agents. For safety reason staff wear gloves, wash hands frequently to prevent spread of germs. Caution exercised around aircraft controls, emergency equipment. Proper disposal protocols for waste, sharps, biohazards.

Figure 2.4 – Cleaning truck

Unloading and loading of luggage - usually performed by dedicated staff. They can be equipped with auxiliary equipment - small tractors for trolleys, conveyors, elevators, and vehicles for handling containers. (Figure 2.5)

Figure 2.5 – Baggage conveyor

Provision of in-flight meals - in-flight meals are food and drinks for consumption by passengers and crew of the aircraft during the flight. Delivery is carried out by a dedicated service using vehicles equipped with a car lift - a body that rises to the level of the doors of the aircraft using hydraulic lifts. Catering truck brings meal trolleys (Figure 2.6) for replenishing aircrafts catering supplies and retrieves empty trolleys or can wait them back to the flight kitchen.

Figure 2.6 – Catering trolleys

Passenger boarding bridge is engaged with the aircraft to allow the passengers on board to disembark from the aircraft and enter airport building. Or ladder (Figure 2.7) connected to the aircraft to embark\disembark passengers and after they will be delivered to the terminal by apron buses.

Figure 2.7 – Ladder

Anti-icing is carried out if necessary to remove frozen precipitation from aircraft surfaces or to prevent their appearance. The process shown below (Figure 2.8)

It is usually carried out at designated stands or places, where the aircraft is towed by a tractor after loading cargo, baggage, and boarding passengers. Processing with the engines running and processing at the parking lot is also possible - it depends on the rules in force at the specific airport.

The specialized winter operations equipment operated by trained ground handling crews is crucial for safe takeoff in cold weather. Scanners with infrared cameras mounted on trucks identify solid ice buildup on aircraft surfaces needing deicing application. Keeping aircraft surfaces clear of contaminated ice and snow buildup through these technologies is essential for maintenance of lift and avoiding stalled airflow. Mobile trucks with booms, tanks and spraying wands to spray heated Type I deicing fluid to remove snow/ice. Disperses heated Type II anti-icing fluid that coats aircraft with glycol mixture to prevent re-freezing of moisture for a period.

Figure 2.8 - De-icing process

Engine start-up is carried out by the aircraft crew under the supervision of the ground staff, since usually the crew does not have the opportunity to observe the exhaust part of the engines and control their condition visually. The ground staff before and during the startup ensure that there are no foreign objects, people, and special vehicles in the dangerous zones around the engines and the aircraft, by the absence of fluid flows and visible deviations in the operation of the aircraft's engines and systems. After anti-icing, the aircraft must depart within 20 minutes, otherwise re-treatment is required.

Release - includes a pre-flight inspection of the aircraft, observing the start of the engines (if necessary to ensure the start from a ground source of compressed air or electrical power) and, often, towing the aircraft from the parking place to the place of starting the engines (Figure 2.9). Visual, wired or radio communication is organized by the person responsible for the aircraft departure.

Figure 2.9 – Towing of the aircraft

After receiving a report from the crew about the normal operation of the systems of the released aircraft, it disconnects from the wire communication and switches to visual communication in front and to the side of the aircraft. After the crew receives permission from the air traffic controller, the crew visually requests permission to start taxiing from the personnel controlled it. In the absence of obstacles for taxiing, its allowed taxiing to the take-off point [11]. The coordinated efforts between flight crew, push operators and air traffic control enables safe, efficient movement of aircraft around congested ramp areas to their departure taxiways.

We have considered the main works on the ground maintenance of aircraft, now we will turn to the question of optimizing the time for carrying out the described procedures to reduce the probability of further flight delays.

One of the currently widely known principles of time optimization for the implementation of any work is the principle of time management. It is often used by managers in enterprises and institutions.

The essence of time management can be formulated as high-quality performance of work, achievement of set goals in a minimum period. Time management is a set of proven work methods that allow you to manage to do more in a shorter period [12].

The task of effective use of working time is always relevant for managers because they manage not only their own time, but also the working time of their colleagues. The manager distributes the goals and tasks that he sets before people according to the component of "importance - urgency" to achieve the set goal as quickly and efficiently as possible. He plans the total time (a resource allocated to achieving a specific goal) and chooses tasks that are better to delegate to subordinates. It is important to avoid busyness in activities because it occurs when time is used inefficiently. The accumulation of unresolved tasks creates emotional stress, which can eventually lead to stress or chronic fatigue syndrome. Such a psychological state reduces the productivity and quality of the manager's work. The consistency and timeliness of completing tasks helps to find time for one's own needs, which in turn makes life harmonious.

The main functions performed by time management include [15]:

a) goal setting (analysis and formation of personal task);

b) planning (development of plans and alternative options for one's activity)

c) decision-making (making decisions about future cases);

d) implementation and organization (setting up the daily schedule and organization of the personal work process for the implementation of the assigned tasks);

e) control (self-monitoring of work performance results, adjustment of goals);

f) information and communication (search and exchange of information, communication links).

To improve the efficiency of time usage and prevent its unproductive losses, it is necessary for the manager to use a certain algorithm for deciding on the order of execution of this or that work.

a) Is it necessary to do it at all?

Unnecessary work, unfortunately, is always a part of our routine. If a manager spends most of his working day on efficient activities related to unimportant components, he reduces his ability to work on the things that really bring benefits. Method works quite effectively at this stage, in accordance with which it is necessary to ask another question: "What will happen if this is not done at all?" If the answer is: "Nothing will happen", then this type of load can be definetly excluded [16].

b) Should I do it?

Delegation of duties and tasks is one of the components of the manager's work. Failure to delegate authority leads to excessive workload and manager exhausting. According to H. Arkhangelskyi, the effectiveness of a manager depends on 30% of his personal organization, and the remaining 70% - on correctly delegated powers [17].

c) Can the work be postponed?

There is no point in chaotically engaging in labor activities. Each case has its own time limits, which must be observed. You should realistically set deadlines for the work, indicating which work should be started immediately and which is not urgent.

d) Should I perform it urgently?

If the work must be done immediately, then it becomes the central object of the manager's attention, to which he directs all his resources. This approach to organizing time allows you to identify areas of unproductive time loss and minimize them, increasing the effectiveness of the manager's work as a whole.

Let us consider the main parts of ground handling at all stages during turnaround procedure of a\c and indicate time required for it in table, where black color is real time for process, grey is a buffer time limit for each (Table 2.1)

Below we can see that all preparations on example of Airbus 320, which is required 48 minutes, in case if de-/boarding was performed only through forward door, catering delivering has been provided on both part of a\c not simultaneously, which may help to prepare aircraft quicklier that we had.

Table 2.1 - Turnaround time schedule (Airbus A320, 48 minutes)

Id	Task name	Elapse time, min													
		0	4	8	12	16	20	24	28	32	36	40	44	48	52
1	De-/boarding forward door														
2	De-/boarding aft door														
3	Head counting														
4	Security check														
5	Catering door 1														
6	Catering door 2														
7	Cleaning														
8	Cargo forward CC														
9	Cargo aft CC														
10	Bulk CC														
11	Refueling														
12	Pot. Water														
13	Toilet service														

In every step, except security check and head counting, each procedure starts with a delay of 2-4 minutes, leads to increase the ground time of aircraft. Second part of grey color indicate a calculated time allocated for preparation, so ground staff were trying to do their work as quickly as possible, and it has been done successfully.

Every day, after the arrival of the aircraft, as well as before its departure, the employees of airlines, airports, handling organizations carry out certain work to ensure the flight of each aircraft. Checking and preparing the aircraft for flight is the pre-flight preparation of the aircraft. It takes place on three levels: ground service, engineers and crew are involved.

2.2 Slot as a method of reducing delays

Nowadays more and more airports start to implement slot coordination process into their work. It helps to organize effective, structural, and quick service on the apron. Some airports set slots only for a certain period, for example only for the summer, as the tourist season begins, and this helps to facilitate work and organize traffic flows.

Let`s consider what is it and how its impact on ground preparations and delays.

The structure of the CFMU is based on the concept of ICAO CTMO and provides for receiving information about air traffic from the ACC about the number and location of aircraft in the air through FMP (Flow Management Position)- points of organization of traffic flows, which are part of these ACC. FMPs are located in each air traffic control center. The task of the FMP is to ensure the maximum use of the capacity of air routes and ATC sectors, prevent overloading of ATC authorities, optimize air traffic flows, and provide operators with information related to ATFCM for the purpose of effective flight planning.

The essence of the operation of the CFMU is that flight plans are received from the operators to the basic computer ATFCM (IFPS), and the computer, based on their accounting and processing, automatically two hours before each departure, when, if necessary, assigns a slot - the calculated departure time of each specific aircraft, which is different in the upward direction from the scheduled departure time.

On the day of the flights, the ETFMS comes into operation, which receives air situation data from the FMP, processed by the FMD, and the CASA computerized slot allocation system (Computer Assisted Slot Allocation). The CASA computer, based on flight plans, as well as the processing of all messages received from operators and data on air traffic flows from the FMP, calculates and assigns slots, ie. computer-calculated departure time (CTOT) for specific flights, considering airspace congestion.

In addition, the computer calculates optimal routes for redirecting air traffic flows along them, optimizes the entire operation of the ATFCM system, and continuously monitors all flights in progress. This phase of ATFCM operation is called tactical.

Thus, most of the delays in departures from (and to) airports in the European region are due to calculations made by the CASA computer to prevent congestion of aircraft routes and airports.

AIM (ATFCM Information Message) is issued by the CASA slot allocation computer on the day of the flight. These messages may refer to situations related to delays at airports or along the flight route, deterioration of meteorological conditions affecting the performance of flights, etc.

The slot is the calculated take-off time CTOT, which is determined considering the aircraft's flight technical characteristics entered to the computer database, the navigation database, and restrictions at the destination airport. The operator's aircraft is obliged to start the flight (movement) later than the CTOT time specified in the message minus the time required for taxiing specified in the same message. At large, congested airports, the crew should request engine start in advance, considering the accumulation of aircraft on the taxiway, so that there is no delay due to a late start. The crew must always plan to take off at the time indicated by the slot. Permissible deviations from the slot of minus 5 and plus 10 minutes are not intended for the operator, but for the air traffic control controller to allow him to maneuver the situation with the release of the aircraft.

So, as we can see, even during the existence of CTOT time for departure, it is especially important to prepare a\c on time and send ready message to the Tower for CTOT improvement.

We decided to show the role of slot in ground preparation on example of small airport in Greece - Mykonos (LGMK), where the total amount of parking stands is ridiculously small. Notam, issued for this aerodrome, allows maximum time on ground is strictly up to 40 min for all preparations, and Mykonos departure slot revision after departure to this a\p is prohibited and subject to charges, fees may apply. All services should be provided on time, such as fueling, loading\reloading of baggage and pax, additional services, like potable water, toilet service or providing GPU, APU upon crew`s request. Slot is the first reason to meet the allocated time for departure, as there may be financial consequences not even for operator, but for contracted handling company too. This process helps to set time frames for departure more strictly, which affects on preparation time on the ground.

Flight cancellations and delays raise costs for everyone involved, including the airlines, airports, and passengers. Airlines are responsible for paying passengers' compensation for delays and rebooking and housing any impacted customers. In addition, airlines may incur additional expenses due to flight delays, including fuel use, airport fees, and the pay of flight crew members.

Every day, after the arrival of the aircraft, as well as before its departure, the employees of airlines, airports, handling organizations carry out certain work to ensure the flight of each aircraft. Checking and preparing the aircraft for flight is the pre-flight preparation of the aircraft. It takes place on three levels: ground service, engineers and crew are involved.

2.3 Handling equipment and scheme of work on ground

Services, which are provided on ground and systems used:

a) Electrical, hydraulic, and pneumatic supply of aircraft systems.
b) Charging with gases (oxygen, nitrogen, air), fuels and lubricants, special liquids.
c) Heating, air conditioning.
d) Aircraft external wash, de-icing.
e) Diagnosis of various systems, troubleshooting.
f) Cleaning of the salon and toilet compartments.
g) Maintenance of high-positioned elements of the aircraft.
h) Refueling - mobile refueling units, centralized refueling stations,
i) Providing of compressed gases - oxygen, nitrogen, air, carbon dioxide.
j) Compressor and charging stations (high and low pressure).
k) Heaters and air conditioners.

l) Goods of starting aircraft engines - electric starter start, air start.

m) Aircraft transport means - airfield tractors.

n) Fire-fighting means.

o) Means of maintenance of toilet compartments.

p) Passenger buses.

q) Catering delivery cars with hydraulic system.

It will be better to describe main components from this list and analyze approximate time required for each service. Below is an algorithm (Figure 2.9) of aircraft turnaround process for Airbus 320, which we analyzed previously on chapter 2.1.

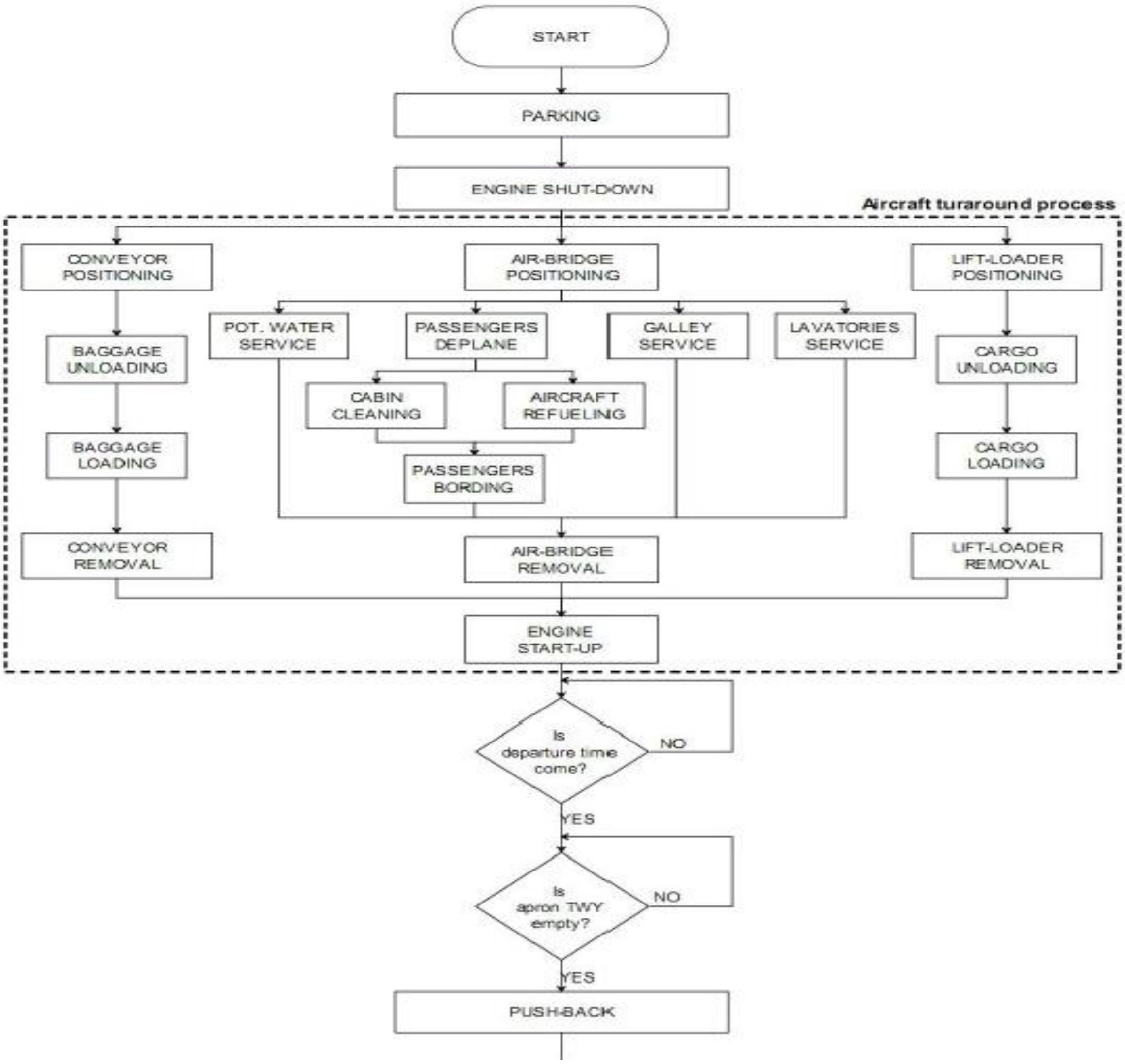

Figure 2.10 – Algorithm of aircraft turnaround procedure (part “on ground”).

Every day, after the arrival of the aircraft, as well as before its departure, the employees of airlines, airports, handling organizations carry out certain work to ensure the flight of each aircraft. Checking and preparing the aircraft for flight is the pre-flight preparation of the aircraft. It takes place on three levels: ground service, engineers and crew are involved.

Everything starts when the a\c lands on the runway. At this time ground handling agency, airline staff and airport staff have been already communicated at the estimated time of arrival of the a\c and they make their preparations on the aircraft`s stand. These preparations include equipment to get ready for action and conducting inspection of all ground support equipment to make sure everything is working smooth, and no surprises are faced when the aircraft reaches the bay. During the parking all the staff and equipment maintain a safe distance from the aircraft, once the a\c jet engines have been cut off, ground support operations begin.

Ground power is usually one f the first facilities engaged with the aircraft especially if the aircraft`s APU is unserviceable. Ground power unit supplies 400 Hz, 115 Volts, three-phase electric power to the a\c.

Passenger boarding bridge is engaged with the aircraft to allow the passengers on board to disembark from the aircraft and enter airport building.

Precondition air unit supplies fresh conditioner air to the aircraft to keep the environment inside the plane comfortable for passengers and crew.

Cargo and belt loader are positioned with the aircraft to unload passenger luggage and released from aircraft cargo compartments. Cargo dollies and baggage carts are towed to the aircraft stand by towing tractors for transferring the unloaded cargo to the airport building or to another aircraft if it is a connecting flight. When uploading is complete, loading of cargo and baggage for the next flight is carried out.

After passengers have exited to the aircraft through the passengers boarding bridge, refueling equipment such as fuel hydrant dispenser engaged to top-up aircraft fuel tank for the next flight.

Lavatory service truck service aircraft waste tank and potable water truck refills the aircraft potable water tank.

Catering truck brings meal trolleys for replenishing aircrafts catering supplies and retrieves empty trolleys or can wait them back to the flight kitchen.

After doing this job ground support equipment disengaged from the aircraft and leave aircraft stand however ground power unit, precondition air unit and passenger boarding bridges remain engaged (Figure 2.11).

By this time airport lounge connected with the aircraft on stand and is already filled the passenger awaiting boarding for their flight.

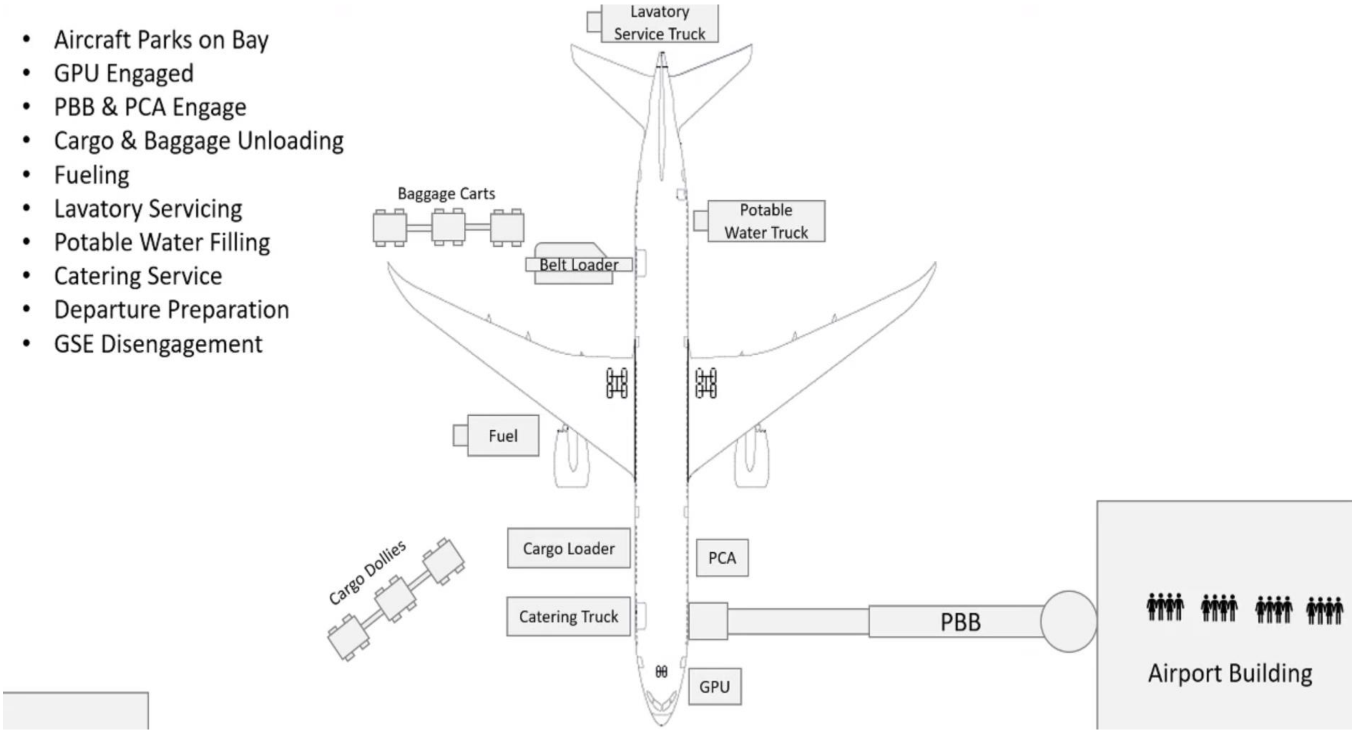

Figure 2.11 – Ground support equipment.

Airline staff begin the boarding process and meanwhile ground handling crew arrange towing tractor and air start unit to prepare for aircraft pushback.

Once all the passengers have boarded the plane, aircraft doors are closed and passenger boarding bridge retracted to its home position. Air start unit is used for a starting one of the main aircraft engines after which ground power and precondition air units can be disconnected. As an idling engine take over the electrical and conditioning system of the aircraft. ASU is also disconnected and during fracture crew wait for the pilots' signal to begin pushback. Once the signal is received tractor pushes the aircraft back to the nearest taxiway, from where the aircraft reaches runway and takes off. In this way, all different ground support equipment works together to service the aircraft and prepare it for the next flight.

In case if remain on the ground for some time approximately 3 hours before departure, an electronic briefing package is sent by mail from the flight dispatcher, which states: weather at the departure and arrival airports; a spare airfield (or several) for various cases (failure of the lighting equipment system, deterioration of weather conditions, etc.), data on the order of departure to the spare airfields and approaches to landing on them; technical status of the aircraft; changes in flight conditions, etc.

1 hour and 15 minutes before departure - a pre-flight briefing of the flight crew is held in a special room at the airport. It is conducted by the crew commander. At the briefing, the flight level (or altitude) of the flight, the route along which the flight will be carried out and its restrictions are discussed, the weather is analyzed, the status of the presence/absence of aircraft malfunctions and the amount of fuel, etc. is made. The possibility of making the flight is finally confirmed at the briefing.

50 minutes before departure - The plane is refueled, the crew in the plane, the commander of the aircraft and the co-pilot check the equipment - each in his place according to his own checklist. Documentation is being checked.

Let us summarize above-described procedure for turnaround flight and preparation for flight in case when aircraft remains on ground:

a) Turnaround flight:
   1) Faster preparation to minimize ground time between arriving and departing flights. Goal is often less than 1 hour turnaround.
   2) Typically, only basic servicing tasks are completed: refueling, light cleaning, wastewater services, catering loading, basic safety/maintenance checks.
   3) No in-depth inspections or major maintenance steps since quick ground time.

b) Aircraft on ground for days/hours:
   1) More extensive preparation work can be completed with additional ground time.
   2) Opportunity for thorough cabin cleaning, major waste removal/refilling.
   3) Maintenance teams can perform safety/service checks in greater depth, address minor issues.
   4) If on ground overnight/multiple nights, additional steps like engine covers, parking brakes, extra security.

5) If more than 72 hours, may require deeper maintenance like tire pressure checks, fluid sampling, battery removal, etc.

The main difference is the depth of servicing and maintenance conducted, driven by the length of ground time available in the operational schedule. Quick ground times focus on faster turn servicing tasks, while longer ground stops enable more thorough checks and deeper maintenance.

Air traffic control officer partially involved in preparation:

a) Communication with crew:
   1) Provides clearance for engine starts and pushback when flight crew is ready.
   2) Advises crew of any traffic or airport conditions that may impact taxi or departure.
   3) Ensures crew has received the latest ATIS with airport and weather information.

b) Communication with ground staff:
   1) Coordinates with ground crews on gate assignments and pushback timing.
   2) Notifies ramp personnel when to expect arriving aircraft and any special servicing or cargo handling requirements.
   3) Contacts airport operations about any factors that may delay or change ground movements and procedures.

c) Additional actions:
   1) Monitors ground movements and aircraft separation on taxiways/runways to prevent conflicts.
   2) Issues taxi instructions to flight crew for routing to/from gate.
   3) Updates flight strips and airport logs with gate assignments, taxi/run times, etc.
   4) Performs radio checks and verifies flight plan routing/details with flight crews prior to takeoff.

The controller serves as the central coordination point to monitor and direct all ground staff actions to ensure safe, prompt, and efficient aircraft preparation and movements.

CONCLUSION TO CHAPTER 2

Every day, after the arrival of the aircraft, as well as before its departure, the employees of airlines, airports, handling organizations carry out certain work to ensure the flight of each aircraft. Checking and preparing the aircraft for flight is the pre-flight preparation of the aircraft. At this stage all depends on professional work, good communication and management. CTOT is an additional goal to leave airport on rime to avoid any fees and do your job satisfied and organize it is an appropriate way to complete all necessary task according to the schedule. A\c preparation time always depends on condition if it is a turnaround flight or aircraft remains on ground for a few hours, days. The cycle of ground handling work is huge, and every step depends on each other, and for any improvement, we need to be aware of all statuses, control all stages at the same time.

In summary, efficient and safe ground handling is a critical and complex work that is vital for on-time, incident-free flight operations. This chapter reviewed key details across the interconnected elements - from arrival, turn servicing, preparation for departure and release phases between landing and takeoff. Smooth coordination between ground crews, airline staff, ATC controllers and flight deck crews is essential to orchestrate the time-sensitive tasks required during congested airport operations.

With growth in air traffic globally, turnaround ground time compression remains an area of intense focus across stakeholders. Expanded adoption of standardized procedures and communication protocols enables clearer handoffs. Continual training refreshers on best safety practices mitigate ramp risks. Optimization analysis balancing costs, emissions, noise and service levels guides infrastructure and equipment investments.

At its core, aviation ground handling succeeds through shared vigilance, capabilities that flex to meet demands and a commitment to continual improvement. As systems integrate tighter and personnel skills rise with technology, the ground dance smooths - keeping passenger experiences positive as the complex ballet of safe aircraft movements plays out behind the scenes shift after shift.

CAPTER 3. METHODS OF INFORMATION DISTRIBUTION AND EXCHANGE

3.1 Verbal and non-verbal information exchange

Communications play an important role in flight, pre-flight preparation and in aviation in whole. Nowadays information exchange become easier than hundred years ago, but for specific task or procedure there is one best variant accordingly. Information exchange divided into verbal and non-verbal communication

There are examples of verbal information exchange:

a) Face-to-face communication
b) Discussion with a group of colleagues or consultations with specialist
c) Radiotelephone communication

And non-verbal:

a) E-mails, letters
b) Video communication / surveillance
c) Printed materials
d) Body language
e) Signals, text messages

All types used in aviation, during aircraft ground preparation there are communication between air traffic controllers, flight crews, and ground handling staff. Between controllers and flight crew: clearances for engine start, pushback, and taxi, taxi instructions and routing details, updated weather/airport conditions (ATIS), timing expectations and departure sequencing. Between controllers and ground handlers: gate assignments, aircraft arrival/departure times, special servicing or cargo handling requirement, coordination for fueling, catering loading, etc. Between flight crew and ground teams: number of passengers/bags to load, fuel/cargo load requirements, servicing requests (cleaning, waste, etc), reporting any aircraft issues requiring maintenance. Between ground teams: division of handling tasks for turnaround process, equipment, and personnel coordination for tasks like refueling, updates on progress of preparations at the gate.

The information exchange ensures shared awareness for all teams involved in process of preparing numerous aircraft simultaneously. Smooth coordination and information sharing is vital for on-time performance.

Face-to-face communication is used during maintenance technician discussing a minor repair issue with the captain at the aircraft. Cleaning staff confirming with catering crew that galley is set up properly. Mechanic describing issue found during walkaround check to pilot.

Discussion with a group is better fit for next situations: ramp supervisors conducting a briefing to coordinate servicing tasks for arriving flights. Briefing between airport ops, maintenance, and air traffic control to coordinate runway closure for required maintenance. Ramp supervisors conducting debrief of ground staff to review operational issues after busy arrival bank.

Radiotelephone communication - pushback tug driver getting clearance from air traffic control to start pushback. Marshalers using headset to get gate assignment from ramp controller. Fuelers contacting flight deck when refueling procedure will start. Air traffic controller coordination, flight plan correction, receiving clearances, instructions.

Emails or letters: dispatch sending detailed turnaround information to the station manager. Sending preliminary operational flight plan for crew before flight. Station manager of flight dispatcher sending flight schedule updates to ground staff sections. Maintenance controller emailing parts requisition paperwork to technician.

Video communication: ground staff monitoring CCTV cameras to coordinate baggage loading. Virtual messaging sign used to indicate gate changes to flight crews and staff.

Printed materials: flight crew reviewing paperwork with latest weather/airfield updates. Flight crew reviewing latest weather and NOTAM printouts before departure. Cleaning staff checking door placards with special cleaning instructions.

Body language: Marshalers using hand signals to guide aircraft to/from the gate. Fuelers using hand signals to guide refueling vehicle back from wings. Marshalers giving turn or stop signals to position aircraft. Pilot using hand signals inform ground about start up process status.

Text messages: cleaning team lead texting updates to gate supervisor on task completion. Last minute gate change updates sent via group text to all ground sections. Confirmations of lavatory servicing completion by text before departure.

Advantages of text form of information transfer:

a) Text messages can be more accurate and specific because they allow you to avoid misunderstandings through clarification and correction.

b) Text form allows you to save the history of messages, which can be useful for further studies, analysis and resolution of conflicting situations or documentation.

c) Additional tools such as abbreviations and codes can be more easily used in text form for quick and efficient information exchange.

Disadvantages:

a) Time required to write - text messages can take longer to write, which can be problematic in situations where time is limited.

b) Difficult to recognize emotions and tone of voice, the text form does not convey tone of voice and emotions, which can lead to misunderstandings or conflict situations.

Voice Form advantages:

a) Speed and direct contact, voice communication can be faster and more direct, facilitating prompt interaction and quick discussion of issues.

b) Voice communication allows you to indicate tone of voice and emotion, which can facilitate understanding of context and intent.

c) Effectiveness in multi-person communication situations - voice communication can be more effective when you need to communicate with several people at the same time.

Disadvantages:

a) Vulnerability to language barriers - language barriers, accents and other factors can cause misunderstandings and complicate the exchange of information.

b) Inefficiency in high traffic situations - in high air traffic situations, voice communication may be less effective due to a mixed and congested voice channel.

So, the advantages of the text form of information transfer are accuracy, specificity, preservation of history, the possibility of using additional tools, and one of the main disadvantages is that a lot of time is spent on writing, the difficulty of conveying emotions and tone of voice. The advantages of the voice form of information transmission include the speed of information transmission, direct contact, easier expression of emotions, efficiency in situations of communication with many people. The disadvantages of this form of information transmission are vulnerability to language barriers, inefficiency in situations of high traffic.

Both methods have their specific applications depending on the context and needs of specific situations. The use of text or voice form may depend on conditions, terms, individual preferences, and specifics of communication between air traffic controllers. In practice, a combination of both methods is often used for optimal information exchange.

3.2 Types of information transmission

Telecommunication is a set of technical devices interconnected by communication channels in a certain order that corresponds to the established scheme of communication organization.

The main tasks of telecommunications are:

a) Ensuring the transmission of messages, orders and various kinds of messages from the unit's command and control bodies;
b) Ensuring direct telephone and radio communication between controllers and aircraft crews
c) Ensuring the reception and transmission of messages about the air and meteorological situation
d) Exchange of various messages with air traffic control centers of other units;
e) Providing telephone and loudspeaker communication between the technological units of airlines;
f) Ensuring communication during emergency rescue operations.

Aviation telecommunications are divided into: aviation fixed telecommunications, aviation mobile telecommunications, aviation radio communication.

Aviation fixed telecommunication is intended for ensuring interaction between ATC centers (points), interaction between air traffic planning and organization centers, interaction of airport services in the course of production activities, transmission of meteorological and flight information, ensuring interaction with airspace users, ensuring the activities of production and dispatch services and administrative and managerial personnel of civil aviation, data transmission.

Aviation fixed telecommunication uses voice (telephone) communication channels organized on the principle of direct or dial-up connections with the installation of operational communication equipment at the workplaces of air traffic controllers.

Aviation mobile telecommunication is intended for providing air traffic control centers (points) with radio telephone communication with aircraft and data transmission, providing ATC centers (points), emergency rescue services with communication with the crews of aircraft in distress or in distress.

Aviation mobile telecommunication is organized with the use of HF, VHF, and satellite radio communications. Organizations (ATC units) develop a scheme for the organization of aviation mobile telecommunications.

The current way ATC and pilots communicate is via radio messages that are transmitted to the pilot's headset on specific frequencies that are assigned by ATC. This message transmission between the pilot and ATC is a four-step process that typically includes: ATC sends a message to the pilot, the pilot listens to the message, the pilot then repeats the message back to ATC, and finally, ATC either accepts or corrects the message. The portion where the pilot reads back the message to ATC is known as the readback, while the portion of the process where ATC listens and corrects the message is known as hear back. This iterative four-step process is referred to as the "pilot/controller communication loop". When ATC accepts that the readback matches the hear back, ATC closes the "communication loop" between the pilot and the controller, thus indicating successful communication. The communication is considered successful when the transmitted message is acknowledged and mutually understood by both the pilot and the controller. This is a continuous process that begins when the pilot requests to ramp out and taxi on the runway and ends when the aircraft reaches its destination and is parked at the airport. [19].

Voice communication is especially important but not effective as a text in case where delays occur. Basically, text or photo information are easily to remember neither than voice. Text allows for clear communication, as messages can be re-read, contain more details, it leaves a recording, which is useful for documentation, reference, and accountability. Accents, language barriers or pronunciation may cause a difficult situation during voice communication. But there are some disadvantages, such as miss click, wrong address, there is an increased risk of misinterpreting leading to misunderstanding. If we are talking about turn around procedure of a\c, we can see that ATCOs cannot affect on ground preparations and delays in it, as a result their clearance for start-up, taxiing etc. depends on efficient work of pilots and ground handling staff.

Also, one of the efficient ways to communicate with ground is a cellular data. There are several advantages to using it on board an aircraft. This type of communication allows pilots to contact with the ATC Tower, ground handling personnel and other crews from high altitudes and remote locations. Cellular communication can be faster and more efficient, help to increase the number of messages and the amount of information in one message during transmission and exchange, especially when departure delays occur and are issued due to the work of ground handling, processing of new slots, delays due to technical malfunctions, bad weather, etc. The system allows pilots to always be in contact with the flight controllers. This is especially for private or commercial flights, where crew-dispatcher communication always requires speed in sending information or requests and receiving an efficient and prompt response. [20]

In case when a\c departs with a delay and has not enough time for refueling, cleaning, toilet, and other services at the a\p of destination, pilot may ask a dispatch team to request fuel truck or needed services on standby upon arrival to minimize time on ground. Cellular communication will be more efficient than traditional radio communication and will allow to reduce costs of support and maintenance of equipment. When considering the technical characteristics and requirements for the commissioning of cellular communication during flights, it should also be taken into account that the upper limit of the radio signal frequencies of the 5G network (4.2 GHz) coincides with the lower limit used in aviation. After all, it can affect the operation of devices in aircraft control systems, such as radio altimeters. It is necessary to create and use a so-called "buffer zone" in the adjacent frequency range to prevent interference with aircraft. State aviation authorities should develop their guidelines for pilots to fly areas where aircraft glideslopes are in close proximity to 5G towers to minimize their impact, and establish agreements with development companies for the regulated, safe and efficient use of these areas. [20]

CONCLUSION TO CHAPTER 3

During ground preparations crew, controllers, and agent on ground are in contact from landing to take off. Their communications should be clear, quick, and useful. From 1 to 10 connections with air traffic controller in normal, certain situation is the most popular answer. It means that for all preparations on ground the number of connections up to 10 is enough to get and send necessary information.

On the other hand, when we are talking about occurrence of potential delay or already have delay in ground for any reason, we can see that amount of connections increase, times of connections became bigger, initiated not only from crew for clarifications but from air traffic controller too.

Effective communication through optimal information flow and exchange methods is vital for coordinated, safe and efficient aviation ground operations. As discussed in this chapter, both verbal means like radio telephony and non-verbal mediums including text messaging play integral roles tailored to specific stakeholders' needs across the interconnected workflow touchpoints. Voice channels promote prompt clarity for time-sensitive air traffic control instructions to flight crews. Printouts and terminal displays quickly relay updates to numerous personnel simultaneously. Digital messages offer timestamped documentation trails for reference and accountability. And hand signals visually cue ramp vehicle movements where headset coordination is implausible. As information and communication technologies continue advancing, aviation ground handling can further optimize interactivity. Integrated, smart workflow platforms linking task status in real-time across operators, contractors and airline ops personnel streamline aircraft servicing. Biometric-enabled augmented reality headsets with voice command input/output boost controllers' and technicians' flexibility. And data analytics on usage patterns tailor interface enhancements to smooth pain points.

By leveraging the growing toolkit of information sharing innovations while retaining legacy backups for redundancy, the ground service stays nimble - poised to exchange mission-critical details at speeds matching flight operational tempo increases in the years ahead.

CHAPTER 4. CONCEPTUAL MODEL OF THE SYSTEM FOR INFORMATION TRANSMISSION BETWEEN THE GROUND HANDLING AGENT OR COMPANY AND THE AIR TRAFFIC CONTROLLER

4.1 Research of the most efficient type or information transmission for potential system based on expert judgement method

Release of aircraft for flight includes a pre-flight inspection of the aircraft, observing the start of the engines (if necessary to ensure the start from a ground source of compressed air or electrical power) and, often, towing the aircraft from the parking place to the place of starting the engines. Visual, wired or radio communication is organized by the person responsible for the aircraft departure. After receiving a report from the crew about the normal operation of the systems of the released aircraft, it disconnects from the wire communication and switches to visual communication in front and to the side of the aircraft. After the crew receives permission from the air traffic controller, the crew visually requests permission to start taxiing from the personnel controlled it. In the absence of obstacles for taxiing, its allowed taxiing to the take-off point. Visual, wired or radio communication is organized by the person responsible for the aircraft departure. After receiving a report from the crew about the normal operation of the systems of the released aircraft, it disconnects from the wire communication and switches to visual communication in front and to the side of the aircraft. Voice communication is especially important but not effective as a text in case where delays occur. Basically, text or photo information are easily to remember neither than voice. Text allows for clear communication, as messages can be re-read, contain more details, it leaves a recording, which is useful for documentation, reference, and accountability.

Pilots, controllers, and agent on ground are in contact from landing to take off. Their communications should be clear, quick, and useful. We need to compare and analyze which type of information transmission is more useful, comfortable for pilots, ground handling staff and air traffic control officer. To deal with it we created a list of questions (Appendix A) for personnel and ask them to complete it. Below (Figure 4.1 - 4.6) is the result of their answers:

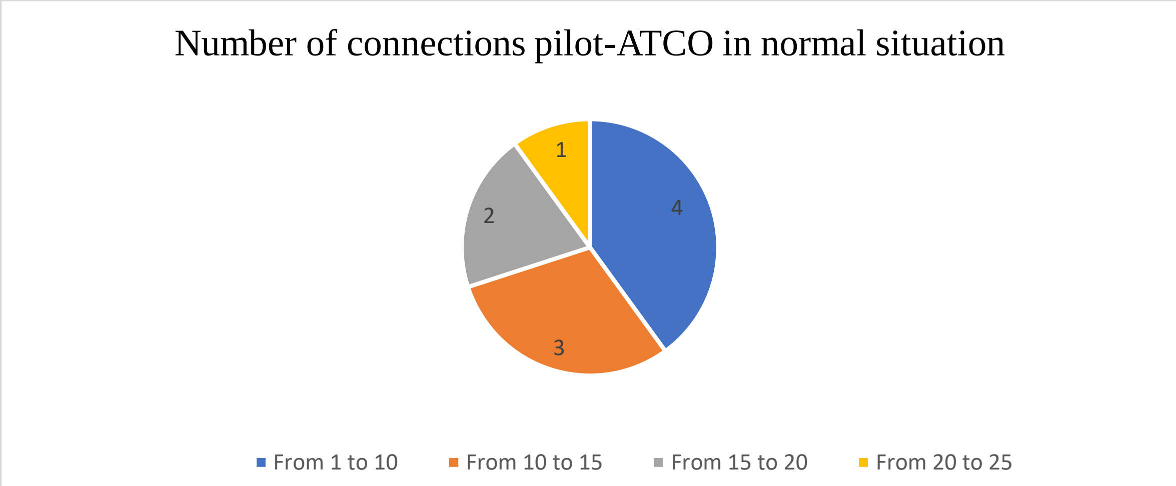

Figure 4.1 – Question 1

Here we can see, from 1 to 10 connections with air traffic controller in normal, certain situation is the most popular answer. It means that for all preparations on ground the number of connections up to 10 is enough to get and send necessary information such as clearances for engine start, pushback, and taxi, taxi instructions and routing details, updated weather/airport conditions (ATIS), timing expectations and departure sequencing.

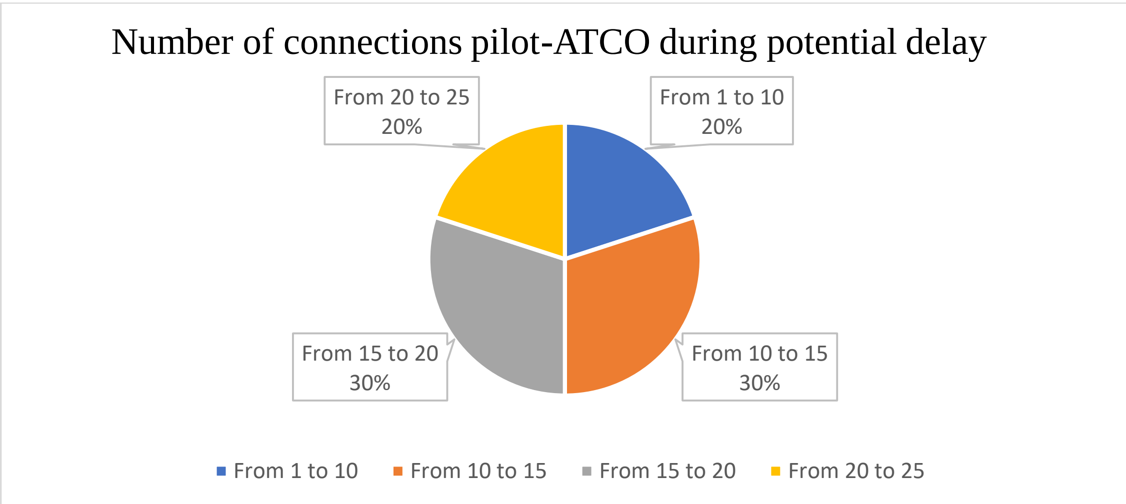

Figure 4.2 – Question 2

If we are talking about occurrence of potential delay or already have delay in ground for any reason, we can see that amount of connections increase. From 10 to 15 and from 15 to 20 take 30% of answers, so we can consider as15 is average value. So, it takes more time to coordinate, get instructions, share status, request services once again or ask to check pax status, neither during normal situations without delay.

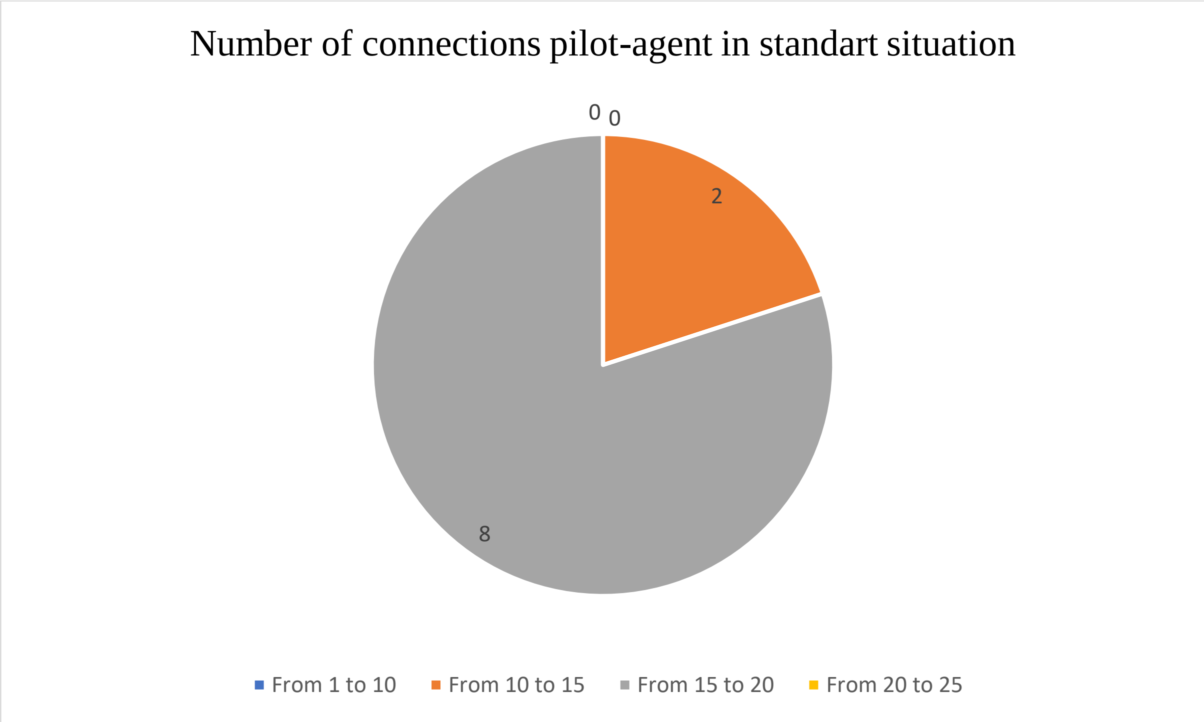

Figure 4.3 –Question 3

Crew communicate with ground handling agent more often than controller and the diagram can confirm it. Up to 20 connections is required for smooth preparation, to receive information about number of passengers/bags to load, fuel/cargo load requirements, servicing requests (cleaning, waste, etc.), reporting any aircraft issues requiring maintenance, etc.

The number of connections is becoming bigger in case if there are any problems with any service or their absence. From 20 to 25 times crew contact with agent on ground. As interviewed pilots say it is because not only one person works with one aircraft, usually it is a team, who also need to communicate, check needed information, or request additional service. Everyone knows their responsibilities and work on it, crew also know the correct order of all procedures and may prepare something by themselves to accelerate one or another process. So, ground preparation is a strong ordered process.

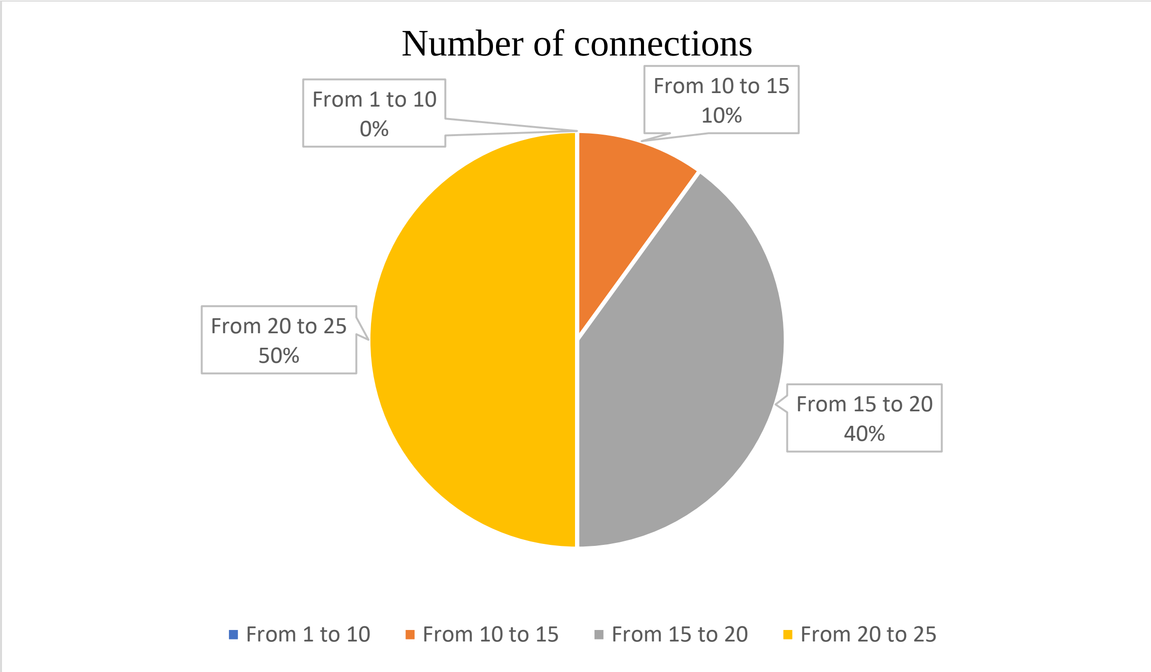

Figure 4.4 – Question 4

As interviewed pilots say it is because not only one person works with one aircraft, usually it is a team, who also need to communicate, check needed information, or request additional service.

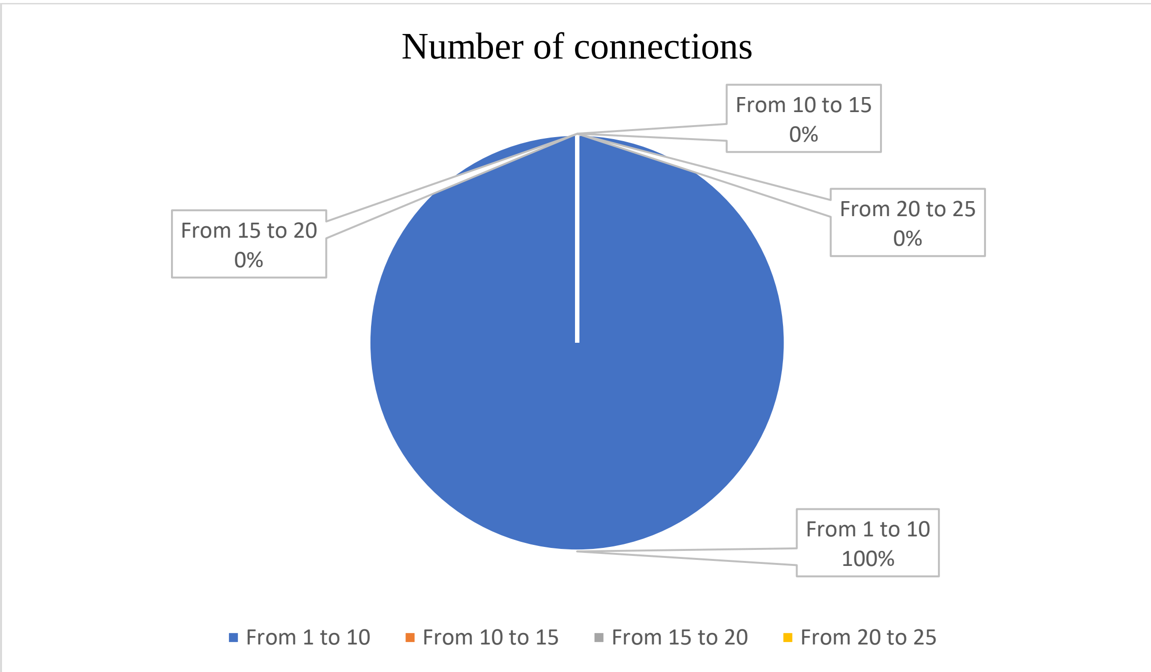

Figure 4.5 - Question 5

So, for reason to exclude defined number of connections, which was done due to mistakes, wrong instructions, or not in-time request, we asked one more question to clarify how many times crew contact with ground agent time after time. Answer shows than up to 10 connections. Additional time required for it, we can try to minimize it, but cannot totally avoid due to human factor.

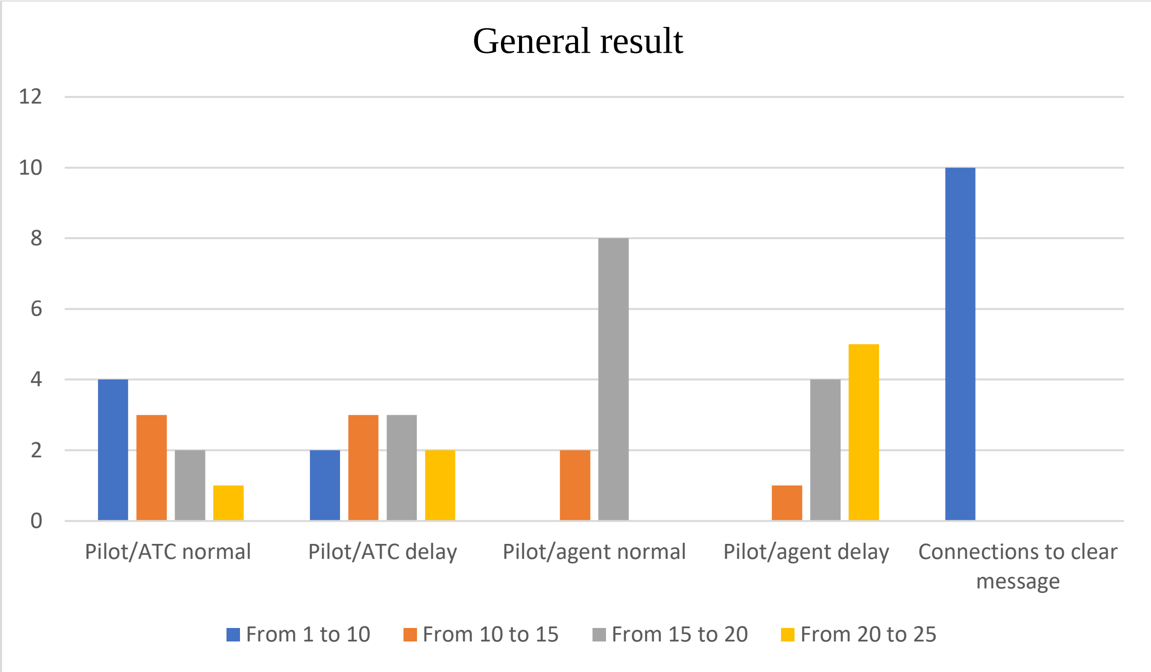

Figure 4.6 – General result of poll

To summarize our poll result, there are more connections between crew and air traffic controller in standard, normal preparation on ground neither uncertain situation of delays. The same are in force for communication between crew and ground agent. So, we must minimize this number of connections between all involved parties and organize more smooth services.

To implement new system, it is important to understand which type of information receiving is more suitable, and handling company staff in Turkey were interviewed about it, below tables (Table 4.1- 4.5) shows the opinion of 5 experts. The task was to evaluate types of receiving information, which is comfortable.

Matrix of individual references, estimated r is equal:

If $w_{i*} >> w_i$ (is more difficult), r=1

If $w_{i*} << w_i$ (is less difficult), r=0

If $w_{i*} = w_i$ (are equal), r=0,5

After all the experts have completed their tables, the organizers of the examination create a summary table (Table 4.6). Next, the ranks in the final table are summed up separately by rows and columns.

Table 4.1 – Expert 1

Types	Voice	Body language	Video surveillance	Visual (static image)	∑	R
Voice		1	0	0,5	1,5	3
Body language	0		0	0	0	4
Video surveillance	1	1		0	2	2
Visual (static image)	0.5	1	1		2,5	1

Table 4.2 – Expert 2

Types	Voice	Body language	Video surveillance	Visual (static image)	∑	R
Voice		1	1	0	2	1;2 / 1,5
Body language	0		1	0	1	3;4 / 3,5
Video surveillance	0	0		1	1	3;4 /3,5
Visual (static image)	1	1	0		2	1;2 /1,5

Table 4.3 – Expert 3

Types	Voice	Body language	Video surveillance	Visual (static image)	∑	R
Voice		1	0,5	0,5	2	1 / 1
Body language	0		1	0.5	1,5	2;3 / 2,5
Video surveillance	0,5	0		0,5	1	4 / 4
Visual (static image)	0,5	0,5	0,5		1,5	2;3 / 2,5

Table 4.4 – Expert 4

Types	Voice	Body language	Video surveillance	Visual (static image)	∑	R
Voice		1	1	1	3	1
Body language	0		1	1	2	2 / 2
Video surveillance	0	0		0	0	4 / 4
Visual (static image)	0	0	1		1	3/3

Table 4.5 – Expert 5

Types	Voice	Body language	Video surveillance	Visual (static image)	∑	R
Voice		0,5	0	1	1,5	2;3 /2,5
Body language	0,5		0,5	0,5	1,5	2;3 /2,5
Video surveillance	1	0,5		0,5	2	1/1
Visual (static image)	0	0,5	0,5		1	4/4

The resulting sums of ranks determine the result. The sums only by rows or only by columns. Both sums are determined only to check the result. If compare the sums by rows, then the factor with the highest sum of ranks takes the 1st place, and if you compare by columns, the lowest. To draw final conclusions based on the ranking results, we need to check the consistency of the experts' opinions.

Table 4.6 – Summary table of expert`s opinion

Experts	Criteria			
	Voice	Body language	Video survaillance	Visual (static image)
	w_1	w_2	w_3	w_4
1	3	4	2	1
2	1,5	3,5	3,5	1,5
3	1	2,5	4	2,5
4	1	2	4	3
5	2,5	2,5	1	4
$R_{гр}$	1,8	2,9	2,9	2,4
D_j	0,825	0,675	1,8	1,425
δ_j	0,9082951	0,821583836	1,341640786	1,193733639
V_j, %	50,460839	28,33047711	46,2634754	49,73890161

Determine of expert`s group opinion R_{grj} using formula (4.1):

$$R_{grj} = \frac{\sum_{i-1}^{m} Ri}{m} \tag{4.1}$$

where m=5, R_i – rang for each criteria.

Determine the coordination of expert`s opinion D_j by the formula (4.2)

$$D_j = \frac{\sum_{i-1}^{m}(Rgrj-Ri)^2}{m-1} \tag{4.2}$$

where m=5, R_i – rang for each criteria, Rgrj – rang for group opinion.

Determine square average deviation δ_j using formula (4.3):

$$\delta_j = \sqrt{D_j} \tag{4.3}$$

Determine coefficient of variation V_j by formula (4.4):

$$V_j = \frac{\delta_j}{R_{grj}}\ 100\% \tag{4.4}$$

where m=5, Rgrj – rang for group opinion.

If coefficient of variation is $V_j < 33\%$ - opinion of experts coordinated.

If coefficient of variation is $V_j > 33\%$ - opinion of experts are not coordinated.

For evaluation of coordination on all process it is necessary to use Kendal`s coefficient by formula (4.5) of concordance or to provide interrogation again.

$$W = \frac{12S}{m^2(n^3-n)-m\sum_{j=1}^{m} T_j} \tag{4.5}$$

where m=5, n=4, S – sum.

If coefficient of concordance is W> 0,7 – opinions of experts are coordinated.

If coefficient of concordance is W< 0,7 – opinions are not coordinated.

Compare opinion of group experts and expert 1 by helping of rating correlation coefficient Spirman`s correlation coefficient r_s by formula (4.6):

$$r_s = 1- \frac{6\sum_{i=1}^{n}{(x_1-y_1)}^2}{n(n^2-1)} \tag{4.6}$$

The significance of the calculation W, criterion - x^2 by formula (4.7):

$$x_f^2 = \frac{S}{\frac{1}{2}m(n+1)-\frac{1}{12(n-1)}\sum_{j=1}^{m} T_j} > x_t^2 \tag{4.7}$$

The significance of the calculation Sturent`s R_s criterion - t_f by formula (4.8):

$$t_f = r_s\sqrt{\frac{n-2}{1-r_s^2}} > t_{st} \tag{4.8}$$

Determine weight coefficient ω_i using formulas (4.9 and 4.10):

$$\omega_i = \frac{C_i}{\sum_{i=1}^{n} C_j}, \quad (4.9)$$

$$C_i = 1 - \frac{R_{ij} - 1}{n} \quad (4.10)$$

Calculation of Kendal`s coefficient, Spirman`s correlation coefficient, comparison calculated value with Student`s coefficient and calculation of weight coefficient, the significance of the calculation, using formulas above including all additional calculations was performed using Microsoft Excel and all received data listed below:

W= 0,859091

W> 0,7 – opinions of experts are coordinated.

r_s = 0,4; $0 \le r_s \le 1$, the coordination of opinions of the group and expert 1 is high. x_f= 1,845; compare with standard value: $x_f \le t$; 1,845 ≤3,3566. And finally, we calculated weight coefficient (Table 4.7).

Table 4.7 – Weight coefficients

Coefficient	Criteria			
	Voice	Body language	Video surveillance	Visual (static image)
ω_i	0,3	0,1	0,2	0,4

According to our research we may make a conclusion that the most useful and effective way to exchange the information is visual method, using static or slowly changeable picture of current situation. Well-experiences pilots recommend using it too and include implementation of specific time of changing situation. Means updating statuses every 5-10 min to minimize connections for clarification or asking for updates.

General result ou research shown on Figure 4.7 below.

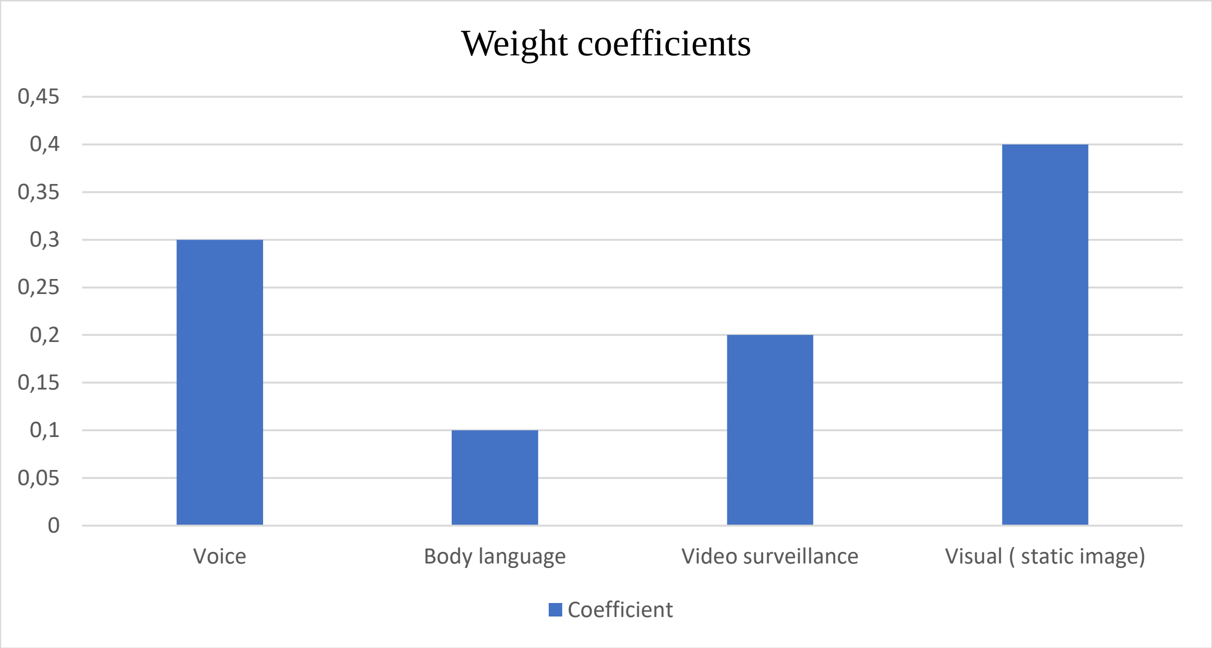

Figure 4.7 – Weight coefficients diagram

4.2 Type of information transmission in the system and context of messages

The advantages of the text form of information transfer are accuracy, specificity, preservation of history, the possibility of using additional tools, and one of the main disadvantages is that a lot of time is spent on writing, the difficulty of conveying emotions and tone of voice. The advantages of the voice form of information transmission include the speed of information transmission, direct contact, easier expression of emotions, efficiency in situations of communication with many people. The disadvantages of this form of information transmission are vulnerability to language barriers, inefficiency in situations of high traffic.

Both methods have their specific applications depending on the context and needs of specific situations. The use of text or voice form may depend on conditions, terms, individual preferences, and specifics of communication between air traffic controllers. In practice, a combination of both methods is often used for optimal information exchange.

So, to avoid disadvantage of text transmission, developing model of system is based on text, but it is better to say on visual statical image, which include numbers and words.

Usually, operator or an airline has contracts with ground handling. It helps to monitor current situation, penalize the agent for inconvenient delays or to pay bonuses, to find out who is responsible for the delay and record all. Previously each company had own system of codes, types of classification and ways to transmission. Nowadays IATA standardized the format with the following codes below:

a) **Others:**

00-05 airline internal codes

06 (OA) no gate/stand availability due to own airline activity

09 (SG) scheduled ground time less than declared minimum ground time

b) **Passenger and Baggage:**

11 (PD) late check-in, acceptance after deadline

12 (PL) late check-in, congestions in check-in area

13 (PE) check-in error, passenger, and baggage

14 (PO) oversales, booking errors

15 (PH) boarding, discrepancies, and paging, missing checked-in passenger

16 (PS) commercial publicity/passenger convenience, vip, press, ground meals and missing personal items

17 (PC) catering order, late or incorrect order given to supplier

18 (PB) baggage processing, sorting etc.

19 (PW) reduced mobility, boarding / deboarding of passengers with reduced mobility.

c) **Cargo and Mail:**

21 (CD) documentation, errors etc.

22 (CP) late positioning

23 (CC) late acceptance

24 (CI) inadequate packing

25 (CO) oversales, booking errors

26 (CU) late preparation in warehouse

27 (CE) documentation, packing etc (Mail Only)

28 (CL) late positioning (Mail Only)

29 (CA) late acceptance (Mail Only)

d) **Aircraft and Ramp Handling:**

31 (GD) aircraft documentation late/inaccurate, weight and balance, general declaration, pax manifest, etc.

32 (GL) loading/unloading, bulky, special load, cabin load, lack of loading staff

33 (GE) loading equipment, lack of or breakdown, e.g. container pallet loader, lack of staff

34 (GS) servicing equipment, lack of or breakdown, lack of staff, e.g. steps

35 (GC) aircraft cleaning

36 (GF) fuelling/defuelling, fuel supplier

37 (GB) catering, late delivery or loading

38 (GU) ULD, lack of or serviceability

39 (GT) technical equipment, lack of or breakdown, lack of staff, e.g. pushback

e) **Technical and Aircraft Equipment:**

41 (TD) aircraft defects.

42 (TM) scheduled maintenance, late release.

43 (TN) non-scheduled maintenance, special checks and/or additional works beyond normal maintenance schedule.

44 (TS) spares and maintenance equipment, lack of or breakdown.

45 (TA) AOG spares, to be carried to another station.

46 (TC) aircraft change, for technical reasons.

47 (TL) stand-by aircraft, lack of planned stand-by aircraft for technical reasons.

48 (TV) scheduled cabin configuration/version adjustments.

f) **Damage to Aircraft & EDP/Automated Equipment Failure:**

51 (DF) damage during flight operations, bird or lightning strike, turbulence, heavy or overweight landing, collision during taxiing

52 (DG) damage during ground operations, collisions (other than during taxiing), loading/off-loading damage, contamination, towing, extreme weather conditions

55 (ED) departure control

56 (EC) cargo preparation/documentation

57 (EF) flight plans

58 (EO) other automated system

g) **Flight Operations and Crewing:**

61 (FP) flight plan, late completion or change of flight documentation

62 (FF) operational requirements, fuel, load alteration

63 (FT) late crew boarding or departure procedures, other than connection and standby (flight deck or entire crew)

64 (FS) flight deck crew shortage, sickness, awaiting standby, flight time limitations, crew meals, valid visa, health documents, etc.

65 (FR) flight deck crew special request, not within operational requirements

66 (FL) late cabin crew boarding or departure procedures, other than connection and standby

67 (FC) cabin crew shortage, sickness, awaiting standby, flight time limitations, crew meals, valid visa, health documents, etc.

68 (FA) cabin crew error or special request, not within operational requirements

69 (FB) captain request for security check, extraordinary

h) **Weather:**

71 (WO) departure station

72 (WT) destination station

73 (WR) en-route or alternate

75 (WI) de-icing of aircraft, removal of ice and/or snow, frost prevention excluding unserviceability of equipment

76 (WS) removal of snow, ice, water, and sand from airport

77 (WG) ground handling impaired by adverse weather conditions

i) **ATFM + airport + governmental authorities:**

Air traffic flow management restrictions

81 (AT) ATFM due to ATC en-route demand/capacity, standard demand/capacity problems

82 (AX) ATFM due to atc staff/equipment en-route, reduced capacity caused by industrial action or staff shortage, equipment failure, military exercise or extraordinary demand due to capacity reduction in neighboring area

83 (AE) ATFM due to restriction at destination airport, airport and/or runway closed due to obstruction, industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights

84 (AW) ATFM due to weather at destination

j) **Airport and governmental authorities:**

85 (AS) mandatory security

86 (AG) immigration, customs, health

87 (AF) airport facilities, parking stands, ramp congestion, lighting, buildings, gate limitations, etc.

88 (AD) restrictions at airport of destination, airport and/or runway closed due to obstruction, industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights

89 (AM) restrictions at airport of departure with or without ATFM restrictions, including Air Traffic Services, start-up and pushback, airport and/or runway closed due to obstruction or weather1, industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights

k) **Reactionary:**

91 (RL) load connection, awaiting load from another flight

92 (RT) through check-in error, passenger and baggage

93 (RA) aircraft rotation, late arrival of aircraft from another flight or previous sector

94 (RS) cabin crew rotation, awaiting cabin crew from another flight

95 (RC) crew rotation, awaiting crew from another flight (flight deck or entire crew)

96 (RO) operations control, re-routing, diversion, consolidation, aircraft change for reasons other than technical

l) **Miscellaneous:**

97 (MI) industrial action with own airline

98 (MO) industrial action outside own airline, excluding ATS

99 (MX) other reason, not matching any code above [21].

To make all notifications easier it will be good to start modeling system, which works like a messenger we use every day in our life. Handling agent receive an information regarding pax delay or regarding cargo, baggage, fuel, then using a couple of buttons send necessary info to the Tower. ATCO will see this message on the screen, and it is not needed to contact with a\c directly to ask about readiness for taxi\push back procedure, etc. And Tower can do their work according to the schedule, and when delayed a\c will be fully ready to depart, agent send a notification that all problems were solved, so a\c is good to go.

The model focuses on the key information exchange during ramp/apron operations between the ground handling agent, who control ramp crews, and ATC, who handles instructions for the flight crew. Constant information sharing on readiness, routing, and aircraft movement between these two key agents helps enable an efficient, safe turnaround process.

Information Sources for ground handling agent it is receiving aircraft operational data, turn priorities, airport conditions, and arrival/departure times from central airline operations center. For air traffic control - get flight plan information, operational conditions, and runway data from airport operations center.

Ground handler notifies ATC departure time to expect aircraft and requests startup/pushback clearance. ATC provides start up approval time, coordinates with ramp tower for gate assignment and issues taxi guidance create sequences departure flow and provides routing to runways considering overall airport traffic situation. Directly communicates with flight crews on aircraft movement clearances and weather, airport updates.

System includes above mentioned codes to minimize quantity of information on the screen and to protect users from unclear understanding of “picture” of preparation.

4.3 Interface of the potential system

Air traffic controllers, flight crew and handling agent work in collaboration, so they need to be aware of current situation without delays in transmissions, on the same time and with the same quantity of information.

Agent, as all other persons, who works on apron, need to feel themselves free in their movements, as they can drive a car, help with baggage, etc. so, in this case new system will be small and useful. Tablet (Figure 4.8) connects to the hand, wrist, thereby ensuring free mobility.

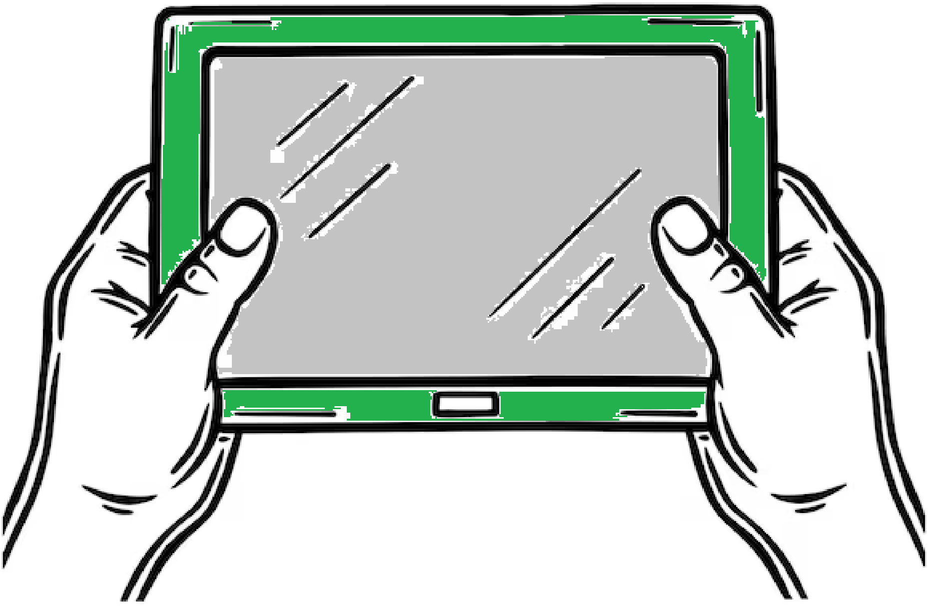

Figure 4.8 – External view of proposed device

Every day, after the arrival of the aircraft, as well as before its departure, the employees of airlines, airports, handling organizations carry out certain work to ensure the flight of each aircraft. Checking and preparing the aircraft for flight is the pre-flight preparation of the aircraft. It takes place on three levels: ground service, engineers and crew are involved.

The user interface is something that should be as clear as possible for most people. If a person opens an app or visits a website and doesn't understand how to use it, they will get frustrated and leave the resource after clicking on different buttons at random for a few seconds.

An interface that is too cluttered is a big obstacle to user understanding. Everything that can be described in one phrase shouldn't be in three. Extra elements and subcategories on the main page are also useless.

Scheme of interface program (Figure 4.9) shows that we take care about getting clearance of actions there.

Figure 4.9 – Proposed program interface

The user must understand what action is being processed by the system. The process of sending a message should be accompanied by the phrase "message being sent" and the end of this process should be "message sent". If an error occurs in the system, the user should also be informed about it, as well as the cause of the error and what they can do in this situation. If the resource involves uploading large amounts of information, you need to place progress bars so that the user can monitor the state of the system.

CONCLUSION TO CHAPTER 4

Efficient communication and information sharing between ramp operations and air traffic control is vital for coordinated, on-time airport ground handling. This chapter analyzed current connection patterns, identifying needs to reduce clarification contacts through a visual-based system. Expert assessment determined static image feeds most usable across fast-paced ramp environments over voice, video or text. Accordingly, the conceptual model promotes a tablet interface leveraging standard IATA delay codes to convey real-time operation status. With timelines auto-updating every 5-10 minutes, the consolidated visual data exchange enhances situation awareness for air traffic and ground controllers sans traffic congestion.

As the ground service grows ever more complex amid airspace density growth, such smart integration that melds existing protocols with emerging technologies promises valuable coordination upgrades. By blending specialty staff intimacy of aircraft servicing needs with big picture oversight of airport flows, shared systems can smooth ubiquitous pinch points. This vision of common views with minimal verbiage may guide stakeholders to see ramp operations through the same lens - pursuing safety, efficiency and harmony. In summary, I highlighted the expert recommendation for a static visual approach along with a tablet-based example interface and benefits of increasing shared situational awareness.

CAPTER 5. LABOR PRECAUTION AND ENVIRONMENT SAFETY

5.1 General regulations of labor protection organization

Labor protection is a system of legal, socio-economic, organizational and technical measures, as well as sanitary-hygienic and medical-prophylactic means aimed at preserving the health and working capacity of a person in the process of work. (according to the Law of Ukraine "On Labor Protection" Article 1)

According to Article 2. of the Law "On Labor Protection", the effect of the Law "On Labor Protection" extends to all enterprises, organizations and institutions, regardless of the form of ownership and types of their activities, to all citizens who work, as well as those attracted to work at these enterprises.

According to Article 4 of the Law of Ukraine "On Labor Protection", state policy in the field of labor protection is determined in accordance with the Constitution of Ukraine by the Verkhovna Rada of Ukraine and is aimed at creating proper, safe and healthy working conditions, preventing accidents and occupational diseases.

For non-compliance with laws and other normative legal acts on labor protection, obstruction of the work of official bodies of state supervision of labor protection, as well as representatives of trade unions, their organizations and associations, the accused persons are brought to criminal, disciplinary, administrative, material, liability in accordance with the law (Article 44 of the Law "On Labor Protection").

5.2 Personnel safety equipment on the apron

Safety in aviation is the important task, especially working on ground, so every member of handling staff must wear necessary safety equipment.

Airport ground staff may be exposed to various types of physical hazards, depending on the specific job functions. The most significant occupational hazards may include: stress associated with carrying heavy loads; repetitive movements associated with maintenance operations of aircraft; collisions with ground movement equipment, ground service vehicles or cargo or aircraft during taxiing, taking off and especially when their carry out landing; and the impact of the weather. Workers may also be exposed to hazards from jet engines.

Maintaining worker safety on the busy airport ramp is crucial. The apron area has numerous hazards between fast moving vehicles, jet engine intakes and blast, extreme weather conditions, and ground support equipment that personnel must stay vigilant against through strict adherence to ramp safety fundamentals.

All employees working on airport aprons are required to wear high visibility safety vests, steel toe boots, hearing protection (Figure 5.1) and other personal protective equipment depending on their roles in fueling, baggage handling, catering delivery or aircraft service functions.

Figure 5.1 - High visibility safety vests and hearing protection

High visibility vests must be worn by all workers. Fluorescent yellow/green with reflective strips highly contrasts against aircraft, equipment, and pavement. Also, paying attention on night period of time, wearing vests is very important.

Airport ramp areas involve high levels of noise that personnel are exposed to from multiple sources, primarily jet engine operations. Hearing damage - prolonged ramp noise above 85-90 decibels lead to gradual hearing reduction and dysfunction for workers. This makes communication more difficult over time. Fatigue - the loud ambient noise leads to increased fatigue among ramp workers compared to most work environments, impacting alertness and increasing risks from heavy equipment operation. Distractions - important ramp communications can be missed or misheard due to high background noise levels, especially during peak periods. This raises chances of accidents and errors. Stress - sustained noise exposure induces greater mental stress and pressure for some employees, indirectly influencing job satisfaction and turnover rate.

Figure 5.2 - Steel toe boots

Safety glasses - wrap around shatterproof lenses protect eyes from blown debris around propellers and jet intakes. Hard hats are required when working zones have overhead structures or loads that pose falling object risks. Work gloves prevent skin exposure when handling cargo, equipment, chemicals, or jet fuel. Dust masks - filter airborne particles from exhaust, tire rubber, cleaning agents, or concrete dust.

The combination of high visibility clothing, reinforced footwear, noise mitigation, eye shields and environmental barriers utilized by ramp workers provides protection across the variety of apron area hazards they encounter daily. Ramp workers must maintain steady awareness of their surroundings, continually scanning for and remaining clear of moving pushback tugs, fueling trucks and baggage tractors transiting around taxiing aircraft. Extra caution is required when crossing aircraft taxi paths, following marshaller signals to ensure no collisions.

Safe operation of various motorized ramp equipment from belt loaders to aircraft tractors demands proper training and licensing, with pre-operation checks required before usage. Careful driving and speed limit adherence prevents apron collisions and injuries. Workers must avoid walking behind aircraft engines during startup and respect intake danger zones. Situational attentiveness around running engines also includes caution for engine blast effects that have blown ramp equipment and people violently backwards. Hearing protection helps mitigate ramp noise exposure leading to long term issues.

Immediate reporting of any injuries, vehicle incidents, spills or ground equipment damage allows timely response and investigation by airport officials. All hands contribute to apron housekeeping, staying vigilant for debris that could get ingested into engines or damage aircraft systems. Ramp safety ultimately relies on everyone maintaining focus, following protocols, and looking out for themselves and coworkers in the bustling, hazardous environment that is the airport ramp.

5.3 Dangerous situation and weather phenomena on apron

Firstly, we should talk about fire, because all planes need fuel, and it is a dangerous liquid. Fires and other dangerous situations can occur on the ramp putting aircraft, equipment, and lives at risk. Some potential scenarios and response protocols include aircraft engine fire, fuel spill, jet blast incidents and adverse weather.

If an engine catches fire during startup/operation, fire response crews rush to the scene and immediately apply fire suppressing agents directly into the engine compartment according to aircraft-specific procedure training, using proper personal protective equipment.

Fuel spill - personnel are trained to quickly shut off fuel system valves/pumps if a tear or disconnect results in spilled jet fuel across the ramp. Absorbent is spread over spill while hazmat crews apply foam agent to suppress vapors and prevent ignition while fuel is contained and cleaned up. Usually, boxes with sand used for absorbing fuel on ground.

Figure 5.3 – Fuel spill

Jet blast incidents - ramp personnel are trained to remain clear of rear engine blast zones. If injured, medical response and treatment would be immediately provided. Investigations help determine adjustments to layouts, blockers, markings etc. needed to prevent recurrences.

Adverse weather - weather like lightning, high winds, or dense fog, the tower and ramp supervisors halt outdoor ramp activity with workers and passengers sheltered indoors, aircraft secured with extra tie-downs (Figure 5.3). Ramp operations resume once conditions clear and are deemed safe again. With extensive procedure training, safety compliance, equipage, and timely emergency response, the impacts of potentially catastrophic ramp accidents can be minimized, keeping personnel and assets protected.

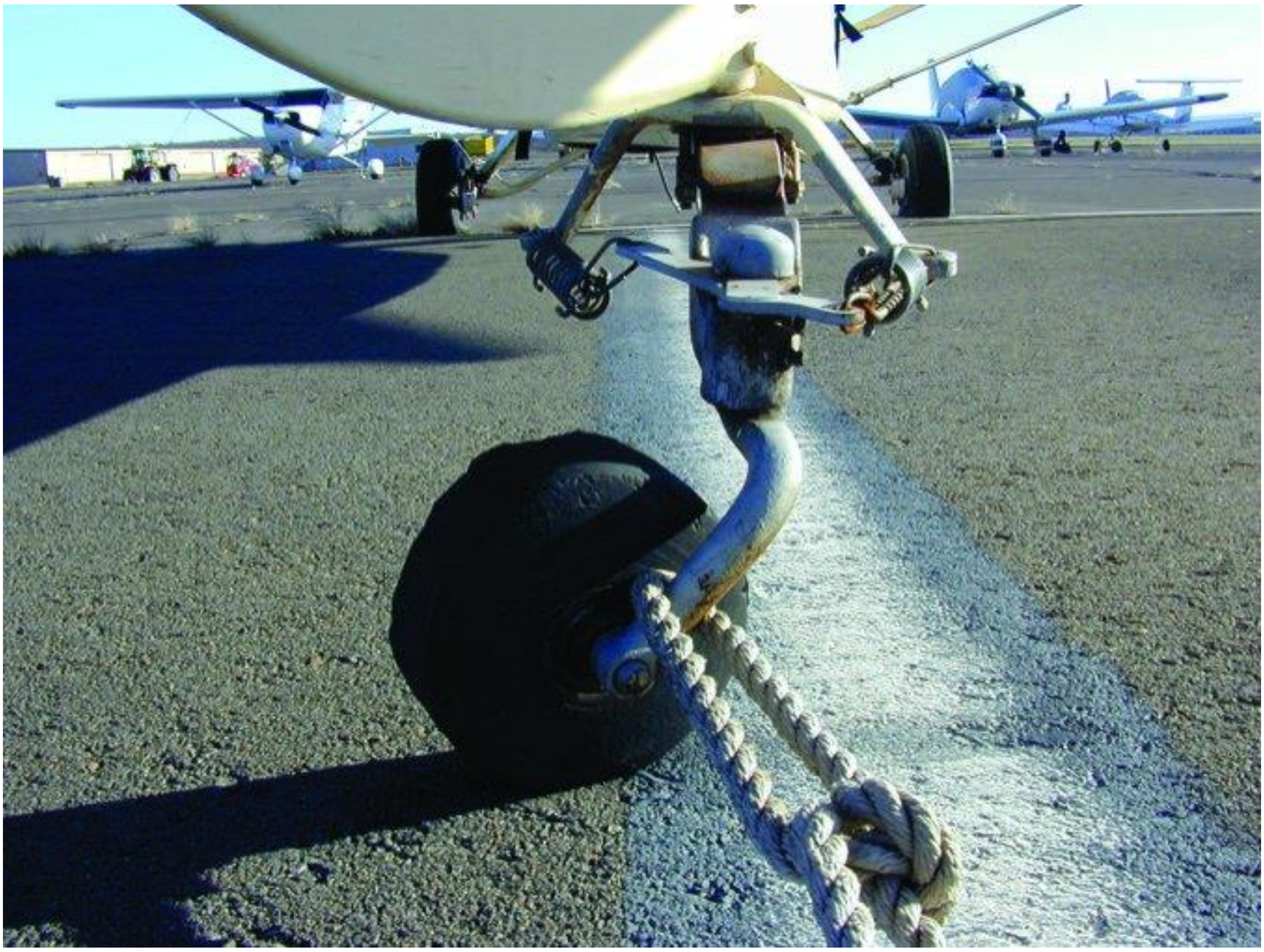

Figure 5.3 – Aircraft secured with extra tie-downs

Here are some additional hazardous situations that can occur on the airport ramp and the safety protocols in place. Aircraft collisions, if a pushback or taxiing aircraft impacts another plane or fixed object, the emergency stop is immediately activated. Airport rescue and firefighting crews dispatched to scene to assess damage and mitigate any leaked fuel while crews evaluate structural impacts.

Foreign object debris - all foreign object debris like debris, bags, and ground equipment parts must be rapidly cleared from aircraft movement areas to prevent sucked into engines or damaging landing gears. Ramp personnel are continually scanning and clearing FOD as soon as observed. Turbine Bursts- failures sending high velocity turbine blade shards in all directions necessitate immediate evacuation from the rupture zone by all personnel. If fire results, trained responders apply firefighting foam directly into the engine intake until the blaze is fully extinguished.

Hydraulic fluid leaks - ramp crews stop the leak at the source by shutting down the system and preventing any ignition sources nearby. Absorbent socks contain the spilled fluid which can degrade pavement integrity over time. The aircraft is thoroughly inspected for the cause of the leak prior to further operation.

Fast response across these varied hazards according to extensive airport emergency planning and drills aims to halt escalation, protect human lives, and allow investigation into how to prevent recurrences through changes to equipment, procedures, or personnel training.

5.4 Environmental protection

Environmental safety and environmental protection involve reducing the negative impact of aviation activities on the environment, determining the environmental capacity of airports, strengthening the role of environmental management, improving and developing the national regulatory framework and adapting it to international requirements. In order to regulate environmental protection activities, the State Aviation Administration is developing and implementing a regulatory framework that will allow the implementation of ICAO practices and recommendations in the aviation environmental protection policy.

Ukraine fully supports ICAO's environmental policy and practice as defined by ICAO Assembly Resolution A39-2 and strives to achieve the global desired goal of maintaining a neutral growth in carbon emissions from international aviation starting in 2020, as well as the introduction in 2020 of a global market mechanism created to reduce emissions from civil aviation. The market mechanism should take into account the principle of common but differentiated responsibilities and respective capabilities, special circumstances, as well as the principle of non-discrimination and equal and fair opportunities. The main problems of environmental protection from the impact of aviation include:

a) air, soil and water pollution due to emissions of harmful substances from aircraft engines and stationary sources;
b) noise pollution;
c) irrational planning and organization of land use;
d) negative impact on the environment during the transportation of hazardous and radioactive substances, including accidental pollution due to the use of low-quality, outdated equipment.

Aircraft, ground vehicles, and airport operations can generate pollution impacts on local air, soil and water if hazardous emissions and discharges are not properly controlled. Some key elements include:

Air - jet exhaust contains nitrogen oxides, carbon dioxide and fine particulate matter emissions that can reduce regional air quality and contribute to climate change long term depending on volume and concentration.

Soil - leaked jet fuel, oil drips from engines and GSE can permeate into soils, altering PH levels that support vegetation growth and microbial balance around airports over years. Deicing fluid leaks also degrade soil over recurring seasons.

Water - deicing agents with glycol content that runs off into streams, wetlands and ponds increases biochemical oxygen demand levels, harming aquatic life support systems if not contained and processed. Also risks groundwater table impacts.

Governmental emission regulations, airport sustainability programs and airline initiatives focusing areas such as reduced engine idling times, ground support equipment electrification, better containment infrastructure, bio remediation applications, and more help avoid and reduce pollution levels related to daily flight operations. Continual improvement tracking via persistent monitoring spotlights progress as well as areas needing additional environmental target support. Ramp operations involve extensive coordination of fuel, deicing fluid, and waste streams in a condensed physical airport environment surrounded by neighboring communities. Continual enhancements through new technologies, infrastructure upgrades and optimized procedures aim at the critical balance of fast but eco-conscious ground handling.

There are some key aspects of environmental protection and sustainability factored into airline aircraft ground handling operations. Emissions reduction: use of fixed and mobile ground power units instead of aircraft auxiliary power units while at the gate to limit emissions and noise exposure. Fuel spill prevention: regular inspection and maintenance programs for fuel tankers along with fueling procedures focused on spill avoidance. Fluid containment: deicing fluid collection processes to recover and contain spent glycol runoff to avoid pollution discharge. Recycling: extensive sorting of aircraft and terminal waste streams with high percentages recycled. Cleaner vehicles: ramp fleets converting to electric ground support equipment from traditional diesel- and gas-powered vehicles to cut local air pollutants. Light pollution minimization: directing ramp flood lights and equipment lights downward during overnight operations to avoid lighting nuisances.

CONCLUSION TO CHAPTER 5

Aviation activities have a great impact on people's lives. Aviation is the biggest source of environmental pollution. This pollution causes deterioration of conditions and life expectancy. In addition, this activity affects the life of wild animals, plants and climate change. Safety basic steps are grounding wires are attached to avoid static sparks, fuelers use headset communication with the flight deck, emergency fuel shut offs accessible by fuelers and pilots, staff wear gloves, wash hands frequently to prevent spread of germs, caution exercised around aircraft controls, emergency equipment, proper disposal protocols for waste, sharps, biohazards. Ramp operations resume once conditions clear and are deemed safe again. With extensive procedure training, safety compliance, equipage, and timely emergency response, the impacts of potentially catastrophic ramp accidents can be minimized, keeping personnel and assets protected.

Maintaining proper labor protections and environmental sustainability are critical responsibilities for airport ramp operations. The hazardous working conditions on airport aprons with numerous safety risks necessitate strict protocols around high visibility clothing, hearing protection, equipment licensing, and situational awareness to prevent injuries. Quick response to emergencies through training and preparedness minimizes damage when incidents do occur. The condensed nature of the airport environment also leads to aggregated pollution impacts if emissions, fuel leakage, and hazardous discharges are not properly contained and managed. As ramp activities continue intensifying with aviation growth, persistently evolving technologies, infrastructure, and optimized procedures must target lower environmental footprints along with safer working parameters for personnel. Continued progress tracking and accountability across both labor and sustainability indicators will reinforce the improvement efforts. Most importantly, instilling a culture of ramp safety and environmental consciousness through procedures, equipment procurement criteria, training, and workforce engagement empowers everyone to contribute to positive outcomes in these critical areas.

GENERAL CONCLUSION

This thesis conducted an in-depth analysis of aircraft ground handling operations, focusing on processes, communications, and potential improvements to minimize flight delays. A review of flight delay statistics revealed the main sources stemming from airlines, airports, air traffic control, weather, and other operational factors. Recommendations centered around enhancing information exchange between ground staff, air traffic control, and crews to swiftly make decisions during irregular operations. Additional focus areas involved optimizing ground time through arrival and departure slot coordination as well as equipment and workflow innovations.

Analysis of the interconnected communication flows pointed to opportunities in standardizing verbal and digital mediums to enable clearer, timely coordination during normal and disrupted turnarounds. A conceptual integrated data sharing system aims to drive more transparent and ultimately more predictive ground handling amidst the complexity of airport ramp dynamics. Also, thesis has explored methods of information transmission between ground handling agents and air traffic controllers to improve coordination and efficiency during aircraft turnaround operations. The analysis began by assessing current communication patterns, identifying needs to streamline contacts and enhance situation awareness. Expert evaluation determined a static visual interface leveraging standard delay codes would prove most usable for fast-paced ramp environments over voice, video or text.

Overall, as air traffic and apron congestion scales globally, the analysis spotlights critical needs around deeper information integration between the numerous airport stakeholders. Background workflow optimization and infrastructure upgrades further strengthen the platform. With proactive communication protocols and a commitment to safety and sustainability, efficient ground operations can continue matching rising volumes while improving passenger experiences. Accordingly, the conceptual model promoted a tablet-based system to convey real-time operation status, with timelines - updating every 5-10 minutes. By consolidating data exchange into an intuitive visual feed supplemented by existing protocols, air traffic and ground controllers gain shared visibility to smooth aircraft handling. We should note that tablets are immensely popular nowadays and its available to everyone, and in already used in aviation.

The study also underscored proper labor protections and environmental sustainability as additional critical pillars of airport ramp activities amid intensifying pressures. Strict protocols around high visibility clothing, equipment licensing, emergency response preparedness and pollution containment reinforce the overarching priority of safe, eco-conscious aircraft servicing.

The exploration of existing safety and environmental procedures spotlighted recent enhancements while acknowledging room for continued gains through technologies and infrastructural investments tailored to ramp hazards.

As airspace congestion and complexity continue mounting in coming years, smart integration of technologies with streamlined procedures will grow increasingly necessary. The vision presented of common system views between all controllers, operators and service agents seeks to align stakeholder perspectives. This transparency and coordination promise gains in turnover velocity, cost efficiency and harmony across the airport environment.

In summary, the thesis analysis spotlights opportunities to meld innovations with legacy processes for more seamless ground handling. The recommendations center on a ramp-wide shift towards proactive data utilization, automated workflows and visual metrics. With aviation expanding globally, solutions scalable across varied stations and cultures prove essential. The final conclusions highlight that sustainable capacity gains will rely on both technical upgrades and human teamwork thriving in concert.

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Appendix A

The following list of questions were sent to the pilots for collection their opinions based on experience:

a) How many connections (number of information transmissions) do you initiate or receive from ATCO during ground preparations?

b) How many connections (number of information transmissions) do you initiate or receive from ATCO during ground preparations during potential delays?

c) How many connections (number of information transmissions) do you initiate or receive from handling agent during ground preparations?

d) How many connections (number of information transmissions) do you initiate or receive from handling agent during ground preparations during potential delays?

e) How many connections (number of information transmissions) do you initiate or receive from ATCO or handling agent for clarification, request of status, corrections?

Table A.1 – Expert`s answers

Question №	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert 8	Expert 9	Expert 10
1	8	10	9	6	7	12	18	21	16	10
2	10	13	15	12	10	17	24	16	20	18
3	12	16	28	16	18	25	20	19	14	12
4	15	26	21	18	17	23	18	28	25	19
5	4	7	8	2	7	9	2	5	6	7