DIMENSIONING THE SUB-SYSTEMS OF AIRCRAFT, PASSENGERS AND BAGGAGE HANDLING AS A MULTI-PHASE QUEUING SYSTEM

Ján Bačík – Tamara Ferencová

The thesis is dealing with queuing area, which is a random process satisfying the emerging needs of the mass operator. The issue of queuing is a feature of contemporary life. The work presents basic knowledge of queuing theory, describes the systems and processes. The work is then analyzed in the course of activities of the sub-search service and optimization solution.

K e y w o r d s. Queuing, Multi-phase system, Passengers handling, Baggage handling, Aircraft handling.

1 INTRODUCTION

Addressing issues related to aircrafts, passengers and baggage handling is necessary since the beginning of the aviation. Multi-phase queuing system is now a multipurpose system used, among other, in aviation.

The subsystems associated with the handling at the airport are not anything special today. At each airport, at home and abroad, this issue is given sufficient space and the whole process of multi-phase queuing system continuously streamlines by optimizing. Queuing area is always a hot topic and its analysis helped to optimize a system.

A purpose of this work is to analyze the possibility of queuing theory, to analyze the factors that affect the queuing process efficiency, process information about the process of aircrafts, passengers and baggage handling, and design procedures for optimizing parameters of these sub-systems as a multi-phase queuing system.

2 QUEUING THEORY

Queuing theory is a mathematical theory dealing with the study of systems in which there is a process between customers and service staff. The term "customer" can understand a person, device, product, or any other element that requires the same kind of service. Similarly, the term "service" you can imagine it any element which is able to satisfy customer requirements. With the relation "customer - service" we meet every day in different sectors of human activity. [1]

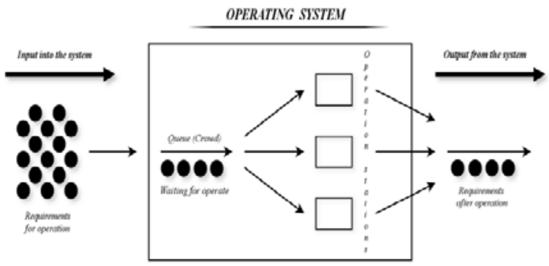
3 QUEUING SYSTEM

The system is in generally complicated, either real or abstract object, in which distinguish the parts, their relation and properties.

Queuing systems (QS) means any system whereby the operator provides some sort of service. Into this system come requirements that require servicing. If the system is unable to provide service immediately, they can wait for service, it means create a crowd, wait in the queue, or they leave the system. Elements providing utilities service called channels (stations). [2]

Elements of queuing system are:

- input current – requirements for operation
- queue (crowd)
- operation station
- output current - requirements after operation



Pic.1 Queuing system

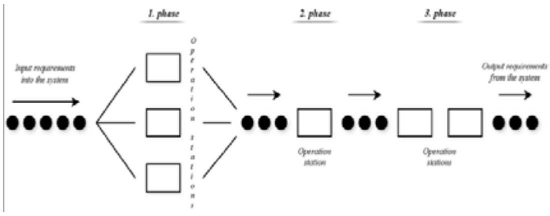
As shown at the pictures into the operating system enter requirements they want service. If the operation station is free, there is the system to immediate operating requirements. Otherwise, the request must wait in the queue (crowd). Waiting time of requirements we understand the operation time from when the request came to the operating system, until it started its operation. The simplest queuing systems have a random waiting time requirements and it is governed by an exponential law. [3]

Service time is the time from the start utility operation station until the time when the station is able to launch other operation requirements. The time required for each operating requirements can be constant or random variable. If the operation involved a man has time service still random nature. The time service is governed by an exponential law. This implies that a large part of the requirements will be served quickly, which may not always be consistent with the practice. [3]

The real moment of arrival of requests is unknown and therefore the entry process requirements that require service, is random.

4 MULTI-PHASE QUEUING SYSTEMS

Multi-phase queuing systems are characterized by a number of traceable mutually dependent or independent systems.



Pic.2 Example of three-phase queuing system

Multi-phase systems have different distribution according to the division in which the correlation length of the queues in the different systems. If the length of queues is independent of the length of the queues of other systems, we speak about multi-phase systems without blocking. If the requirement can leave the system only when the operation ended in the next system, even though that operation under the previous system was over, we talk about multi-phase systems with blocking. Queue may be created only in the first system. These systems with blocking are sensitive to changes in the intensity of the input current. [4]

5 EFFICIENCY CRITERIA IN QUEUING SYSTEMS

Queuing theory is determined in each different system characteristics, which generally constitute the criteria of efficiency. Types of characteristics depend mainly on the type of system. Using the analytical relationships queuing theory can identify a large number of criteria that adequately describe the system. [4]

Among the key elements of queuing therefore include:

- flow of entry requirements - the intensity λ, the average number of requests for service per unit of time or the average length of the interval between two requirements,
- operation stations, their number (n) and the average time needed to serve the same requirements,
- queue and its limitations.

These three elements are in mutual interaction. We can assume that since their parameters can be derived indicators of the effectiveness of queuing. [3]

6 INDICATORS OF WORK EFFICIENCY OF QUEUING SYSTEMS

If we want to investigate the progress of the process we need to know its parameters. The results of investigating are the variables characterizing the progress of process. Otherwise known as the indicators of the work efficiency of the queuing systems. These are the numerical characteristics of the type of mean values and probabilities. The most commonly used are:

1. Probabilistic characteristics:

- probability that all serving channels are free,
- probability that is currently occupied *k* channels,
- probability that all channels are busy,
- probability that the waiting time to start handling is smaller or larger than a certain value.

2. Mean (average) values:

- average number of occupied channels,
- average number of free channels,
- average number of requirements waiting for the beginning of operation,

- average number of requirements contained in the operating system,
- average waiting time for the beginning of operation,
- average time delay of requirement in the system.

3. Evaluative features (ratio characteristics):
- coefficient downtime of operating channel,
- coefficient of use of operating channel,
- coefficient downtime of operating requirement, etc.

These and other numerical characteristics are used for performance evaluation of queuing to check whether the proposed system the operator has the capacity to meet the requirements and it will be asked to decide on the most suitable system, subject to certain criteria of several possible alternatives to the organization. What we use depends on the numerical characteristics of the QS and the purpose of analysis. [5]

7 HANDLING PROCESSES AT THE AIRPORT

It is very important that handling processes occurring at the airport were efficient, fast, quality and comfort. Individual items of handling process are in detail described in the Airport Handling Manual. This document strictly define what the process contains, what procedures must be done, what documents are used, what types of messages to be broadcast, who is responsible for the actions, etc.

The process of handling at the airport can be divided into two groups:

- business handling – handling of passengers, baggage, cargo and mail,
- technical handling – handling of aircrafts. [6]

Response process is composed of individual steps, which follow each other. They form a smooth flow of passengers, baggage, cargo and mail. The process of passengers and baggage handling begins upon arrival at the airport, where passengers in the check-in desk submit their luggage. Process of baggage handling consists of the following steps:

1. Passenger gives his baggage at the check-in desk,
2. The baggage is checked by X-ray if no prohibited items are there,
3. Sorting baggage in the baggage handling system by individual flights,
4. Loading baggage on a device intended for transfer,
5. Transfer baggage from baggage handling system to aircrafts,
6. Loading baggage to the aircrafts.

To good handling of passengers are used handling systems designed to maintain actual information about the passengers during handling. [6]

After completion of the handling at the check-in desk, eventually self-service kiosk, the traveler must submit the passport and customs control, if required by the country of arrival. Next, proceed to security check, during which, along with carry-on luggage inspected for safety. There is checked the contents of hand luggage, and possibly dangerous, prohibited items that passengers can carry. After passing security check passengers entering the private part of the airport, waiting for invite to boarding. It begins approximately twenty minutes before scheduled departure. After notification passengers go through the gate, where their boarding pass and identity are checked again.

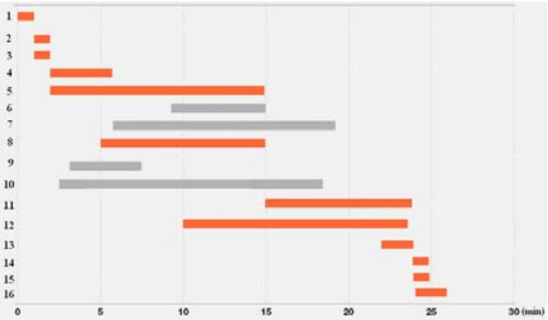
As the handling process of passengers and baggage consists of a number of interrelated activities, as well as process of aircraft handling requires a number of aircraft operations, more or less in successive. [6]

To work in preparing the aircraft for flight is provided with the relevant regulations for the type of aircraft. Between landings and takes off at the airport are doing some activities on the aircrafts. It is a visual check of aircraft parts and systems and control of fuel and any refueling. Within check are removed deficiencies found during the check.

Aircraft handling process generally consists of the following activities:

1. Guiding the aircraft to the stand,
2. Anchoring aircraft - support the wedge chassis,
3. Position passenger stairs or bridges,
4. Supply power, GPU connection, ensuring air conditioning and compressed air,
5. Technical and security check of the aircraft,

6. Deplaning passengers and unloading baggage,
7. Service galleys, disinfecting,
8. Service lavatories and service potable water,
9. Fuel aircraft,
10. Catering,
11. Boarding passengers and loading baggage,
12. Power supply removal, removal stairs or bridges,
13. In winter, if necessary, de-icing aircraft,
14. Push back. [6]



Pic.3 Gant chart of aircraft handling

Loading and unloading baggage and cargo is time-consuming work because of the large volume of cargo that must be within a short time loading and unloading. The main factors affecting the duration of individual activities (arrival / departure of passengers, loading / unloading luggage) the number of passengers, quantity of baggage, but the level of services required by carriers from handling companies.

In analyzing the challenges of airport processes is necessary to consider from witch parts the airport process consists, what are the input parameters, what are the different parameters of the airport process, how these parameters can be influenced by conditions during the calculation of what is wanted and what the result is expressed as units of measurement, as a result can be found used for other tasks.

8 PROPOSAL PROCEDURES FOR THE OPTIMALIZATION OF PARAMETERS OF INDIVIDUAL SUBSYSTEMS OF SERVICE

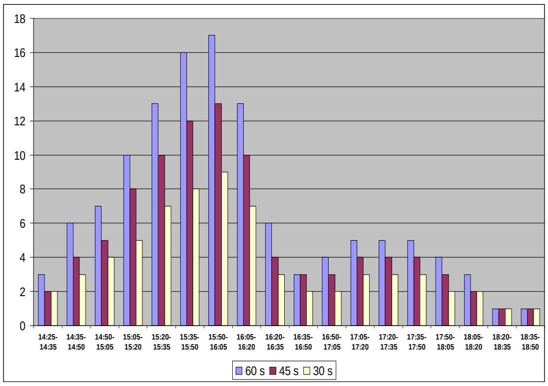
By me proposed models were created by program MS Excel.

In the case of passenger handling model enables display the required number of the check-in counters, security counters or employees in case of change of these parameters:

- the number of entering requirements,
- the length of service of requirements,
- coefficients / indices.

Demonstration of working model was created with respect to the operation of Czech Airlines in Prague-Ruzyne airport, and applied to the peak period.

One of the outputs was to determine the required number of check-in counters depending on the average length of service a passenger.



Pic.4 The required number of check-in counters depending on the time of service

If take a particular case, the time need to operate one traveler in the first phase is 60 seconds, in the second phase is 6 seconds and in the third phase is 35 seconds, get information about the number of operating passengers in various phases.

Time	14:35	14:50	15:05	15:20	15:35	15:50	16:05	16:20	16:35	16:50	17:05	17:20	17:35	17:50	18:05	18:20	18:35	18:50
Passengers 1. phase	35	78	94	141	195	231	249	182	79	41	48	61	70	66	53	32	10	1
Check-in counters 1. phase	3	6	7	10	13	16	17	13	6	3	4	5	5	5	4	3	1	1
Staff 1. phase	5	8	9	12	15	18	19	15	8	5	6	7	7	7	6	5	3	3
Passengers 2. phase	52	115	137	207	286	340	367	268	117	61	70	90	103	96	77	46	14	1
Staff 2. phase	1	1	1	2	2	3	3	2	1	1	1	1	1	1	1	1	1	1
Passengers 3.phase	52	115	137	207	286	340	367	268	117	61	70	90	103	96	77	46	14	1
Counters 3.phase	3	5	6	9	12	14	15	11	5	3	3	4	5	4	4	2	1	1
Staff 3.phase	12	20	24	36	48	56	60	44	20	12	12	16	20	16	16	8	4	4

Pic.5 Summary of passenger numbers, the number of required stations and the number of staff

The next model in MS Excel was created in order to clarify the number of aircraft movements and the use of different types of stands at the airport. The model is designed for general use. Its output is a table which is essentially a diagram from which see how long time spends the aircraft on stand at the airport.

The input data are:

- arrival time of the aircraft to the stand,
- departure time of the aircraft from the stand,
- type / category of the stand.

The table gives the total output in the form of total aircrafts using the stands in each time.

		16:10:00	16:15:00	16:20:00	16:25:00	16:30:00	16:35:00	16:40:00
Type of stand	1	1	1	1	1	1	1	1
	2	0	0	1	1	1	2	2
	3	1	1	1	1	0	0	0
	4	0	1	1	1	1	1	1
Total aircraft		2	3	4	4	3	4	4

Pic.6 Total aircrafts by different types of aircraft stands

More about the individual models and their outputs you can read in [7].

9 CONCLUSIONS

In the design of queuing system at each face two contradictory requirements, and that the customer wants to wait for the shortest period of time, that is the greatest need for capacity, and that by the operation is to reduce costs and minimize the number of service stations. Optimization of queuing system applicable if can be changed the structure of the system (for example number of operation stations), can regulate input current of requirements or change the operating time. It means the possibility of reconciliation with the requirements of the service manual so that the total costs of the queuing process are minimal. [5] The result of optimization of queuing system is usually to find the ideal number of operation stations to be operated to reliably, safely and on time serve all requirements. Providing sufficient service facilities is associated with high material costs, and these may not be used effectively. On the other hand, failure to quickly serve demand resulting from the rise of social costs, means the loss of consumer confidence, as well as increased production costs because of production downtime. It is therefore necessary to find an economic balance between the costs of operation and costs associated with waiting for service. Queuing theory does not solve the problem directly, but provides the necessary information for decision-making process regarding the number and length of the average waiting time.

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AUTHORS´ ADDRESSES

Ing. Ján Bačík, CSc., Katedra manažmentu leteckej prevádzky, Letecká fakulta, Technická univerzita Košice
E-mail: jan.bacik@tuke.sk

Ing. Tamara Ferencová,
E-mail: tamara.ferencova@gmail.com

Reviewer: Ing. Edina Pappová