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APPLICATION OF SIMULATION APPROACH TO MANPOWER PLANNING AT UKRAINE INTERNATIONAL AIRLINES' MAINTENANCE DEPARTMENT

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Abstract. The simulation model for the line maintenance department should be used as a tool to support effective and efficient functioning of every airline. The paper describes application of this model at Ukraine International Airlines for their major maintenance station at Boryspil International Airport in Kyiv, Ukraine.

Keywords: Simulation model, simulation approach, manpower planning, line maintenance, maintenance department.

Introduction

The special role of Ukrainian infrastructure is determined that the country's economy is transport-costly. To earn one nominal dollar of GDP, in Ukraine it should be transported approximately 6 ton-km of cargo. At the same time, for the European Union this index is 0.3 ton-km, which is 20 times less (World Bank 2010; European Environment Agency 2006). The portion of transport and communication in the GDP of the country is 13%. The economic crisis of 2008–2009 has led to the considerable economic downturn. But the available infrastructure was enough for satisfaction of current needs. That affected evaluations of infrastructure as a problematic factor which was not critical enough. At the same time the crisis has stimulated the growth of demand for transport services. But it is too early to call this improvement as constant.

The process of re-establishment in economy and as a consequence in transport sector has started at the beginning of 2010. The gradual recovery from the crisis of the world's economy creates opportunities for economic growth and additional demand for transit. According to this, the standard requirements for transport infrastructure of Ukraine grow. For this moment there is no single powerful and competitive national carrier in Ukraine which causes disintegration of air transportation market between many airlines.

Analysis of the last researches and publications

Line maintenance is also known as short routine maintenance. It includes the regular short haul inspections of aircraft between their arrival, and consecutive departure from the airport. It requires accurate planning and foresight because ninety percent of the cost of line maintenance is attributable to labor.

A significant contribution to the manpower planning has been made by foreign scientists as Bazargan-Lari *et al.* (2003), etc.

Mathematical modeling techniques have been used in the area of maintenance planning. Dijkstra *et al.* (1991), proposed a Decision Support System (DSS) for capacity planning of aircraft maintenance personnel and to solve problems related to the size and the composition of the work force.

Clarke *et al.* (1996) reviewed the maintenance and crew considerations in the basic fleet assignment problem proposed by Hane *et al.* (1995). They included long maintenance and crew constraints, but did not implement the special modeling devices for dealing with short maintenance. Rushmeier and Kontogiorgis (1997) proposed an advanced model for the formulation and solution of large-scale fleet assignment problems that arise in the scheduling of air transportation. Barnhart *et al.* (1998) modified the fleet assignment problem using a string-based model and solution approach to solve simultaneously the fleet assignment and aircraft routing problem, which included maintenance requirements as a constraint. Talluri (1998) addressed the aircraft maintenance four-day routing problem. Mathematical programming models that utilize polynomial time algorithms were used. Sachon and Paté-Cornell (2000) addressed the issues of delays and safety in airline maintenance. A probabilistic risk analysis model to quantify the effect of an airline's maintenance policies on delays, cancellations and in-flight safety was used.

Statement of the problem

The major challenge for every airline is to have safe, airworthy and on-time aircrafts every day. Therefore, the major challenge is to provide efficient maintenance of growing fleet. Simulation modeling is a process by which the basic features of a system are analyzed and simulated by the computer (Bazargan 2010). Then it is used to see the ways in which the new system would operate. It can show what might happen under various conditions and how the new system would operate. Maintenance activities are the backbone of a successful and profitable airline company (Bazargan-Lari *et al*. 2003). Nevertheless, many airports and airlines still have to face departure delays and frequent changes in operations, miss revenue opportunities or waste money because of unused resources of every kind (Kelemen 2009; Bite 2008, 2010).

Ground Handling Services is servicing of an aircraft while it is on the ground between the time it arrives at its parking position and the time it departs on its next flight at an airport. There are two major types of procedures: aircraft and terminal operations. Table 1 represents the major types of operations of ground handling.

Table 1. Procedures of Ground Handling Services

Aircraft Ground Handling	Terminal Ground Handling
• Cabin Services	Departure services:
• Cleaning;	• Check-in:
• Replenishment of on-board consumables or washable items (e.g. soap, pillows, tissues, blankets, etc.)	• Ticket validation;
• Catering;	• Check-in baggage labeling;
• In-flight entertainment;	• Boarding card issuing;
• Minor servicing of cabin fittings;	• Checking the necessary documents for international passengers;
• Alteration of seat configuration.	• Giving points for special airline programs.
• Field Operation Services	• Immigration
• Dispatches the aircraft;	• Passport check.
• Maintains communication with all of the operations at the airport and ATC.	• Security check
• Ramp Services	• Boarding passengers at the gate
• Guiding the aircraft into and out of the parking position;	• Closing the flight
• Towing, moving with pushback tractors;	Arrival services
• Safety measures;	• Passenger de-boarding
• Lavatory drainage;	Staffing
• Water cartage;	• Transfer desks
• Air conditioning;	• Customer service desks
• Air start units;	• Airline lounges
• Passenger boarding and de-boarding;	• Lost and found desks
• Checked-in baggage loading and unloading;	• Information desks
• Gate checked luggage;	Passenger information
• Air cargo, air mail and equipment loading and unloading;	Baggage Handling:
• Catering trucks supply;	• Baggage check-in;
• Refueling;	• Security check;
• Ground power supply;	• Baggage sorting, resorting;
• Passenger stairs supply;	• Baggage reconciliation;
• Wheelchair lifts;	• Baggage loading and unloading;
• Hydraulic mules;	• Baggage forwarding to the baggage claim.
• De-icing;	Cargo and Air Mail Handling:
• Door closing;	• Cargo and mail reception;
• Routine maintenance;	• Publishing transport documents;
• Non-routine maintenance;	• Security check;
• Repair of faults;	• Sorting;
• Wheel and tire check;	• Toll handling;
• Crew transporting to/from the aircraft;	• Loading and unloading;
• Documents signed by the captain;	• Recipient information at arrival.
• Rescue;	
• Fire fighting.	

Input Data

Ukraine International Airlines (UIA), based in Kyiv Boryspil airport, Ukraine, is the flag-carrier of Ukraine serving over 40 capitals and key cities of Western Europe, the CIS, Asia, and Middle East, as well as operates domestic flights within Ukraine. UIA operates over 700 flights per week and provides connections with its international partners' flights to more than 3,000 other destinations across the world. According to the Boeing Company statistics, UIA is the only airline in the CIS which performs full technical maintenance for its own fleet. UIA Technical Division also provides this service to other Ukrainian and international airlines.

As of January 2013, the Ukraine International Airlines fleet consists of the following aircrafts represented in Table 2.

There are 3 types of flights of aircrafts to the station (Boryspil airport): a Through, a Day Hold or a Remains Overnight flight.

Table 2. UIA fleet

Equipment type	In Fleet	Orders
Antonov 148-100	3	1
Boeing 737-300	5	0
Boeing 737-400	4	0
Boeing 737-500	6	0
Boeing 737-800	6	2
Boeing 777-200LR	0	5
Total	24	8

Through Flight: The aircraft is on a transit through the station with minimal ground time. The through flight goes through a departure check while it is on the ground.

Day Hold: The aircraft has one of the routine checks during the daytime before departure.

Remains Overnight: The aircraft remains overnight for one of the routine checks before departure.

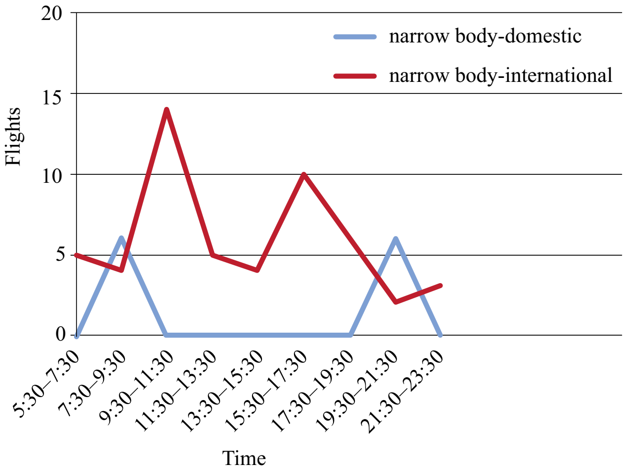

Fig. 1. Arrival and departure waves' distribution of narrow-body domestic and international aircrafts of UIA at Boryspil International Airport

To have efficient manpower planning the number of flights in a typical day (winter) of UIA should be calculated.

Service Check (SVC): A walk-around service and systems check applicable to all fleets, generally done on an overnight basis. Wide-body aircraft get this check done on a day hold as well as on remains overnight. If an aircraft remains overnight at a station with sufficient ground time, a service check will be performed, regardless of the number of days it has been since its last service check. If a higher-level check has instead been performed, it supersedes or signs-off the service check.

Lever 3 Service Check (SC3): Lever 3 service check is a more in-depth service check applicable to all fleet types. This check is also done on an overnight basis. It generally takes between 8–10 hours to complete this check for a narrow-body aircraft and 12 or more hours for a wide-body aircraft. A level 3 service check is a higher level of check than a service check, so a service check is not performed if a SC3 check is due.

Line Package Visit (LPV): A scheduled check applicable to all narrow-body aircraft, generally done on an overnight basis. LPV requires 75 man-hours, and generally one LPV is scheduled at the Boryspil maintenance station in a night. LPV are handled by the night-shift technicians. The Table 4 shows the standard requirements for Boryspil airport of man-hours, ground-time, and technician requirements for a day holds and remains overnights.

Table 3. Man-hours, ground-time and technician requirements for day holds and remains overnights

Fleet type	Ground time	Number of technicians
N/B Dom	< 0.75 hrs	2
	≥ 0.75 hrs	1
N/B Intl	< 0.75 hrs	2
	≥ 0.75 hrs	1

Table 4. Service-check (SVC) man-hours, ground-time, and technician requirements for through flights

SVC				
Fleet type	M/H	Ground-time (hrs)	+/– (hrs)	Number of technicians
N/B Dom	6	6	0.25	1
N/B Intl	8	8	0.25	1

Table 5. Level 3 Service-check (SC3) man-hours, ground-time, and technician requirements for through flights

SC3				
Fleet type	M/H	Ground-time (hrs)	+/– (hrs)	Number of technicians
N/B Dom	16	8	0.25	2
N/B Intl	18	9	0.25	2

The availability of mechanics at different times of the day is the main challenge for maintenance stations. On average, labor represents 13% of maintenance costs. That's why mathematical modeling techniques with other scheduling models are extremely important in manpower planning.

There are three working shifts in 24 hours: day, afternoon and night shifts. Each shift is divided into sub-shifts.

Table 6 projects the shift and sub-shifts schedules at Kyiv Boryspil International Airport.

Table 6. Shift and sub-shifts schedules at KBP

Shifts	Sub-shifts	Start time	End time
Day	1	05:30	14:00
	2	06:00	14:30
	3	08:00	16:30
	4	11:00	21:30
Afternoon	1	13:00	21:30
	2	13:30	22:00
	3	14:00	22:30
	4	14:30	23:00
Night	1	20:30	07:00
	2	21:30	08:00

Simulation Results

To derive the various performance measures for the system *AutoStat* analysis tool should be used. Fig. 2 presents the output of the simulation model for the total technician requirement during each sub-shift. As the figure suggests, there is more demand for technicians during the day shift than during the afternoon and night shifts.

As the through flights require less time to service, the amount of aircrafts serviced by day and afternoon shift increases. However, the routine checks are done during the night shifts require more ground time to complete. Thus, the number of aircraft serviced during night shift is less.

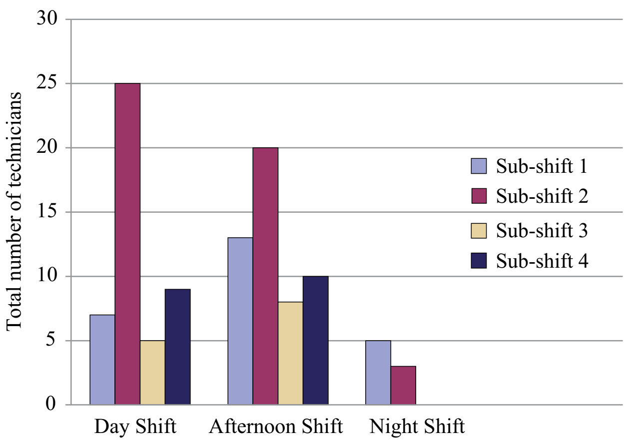

Fig. 2. Total technician requirements for each sub-shift in a day

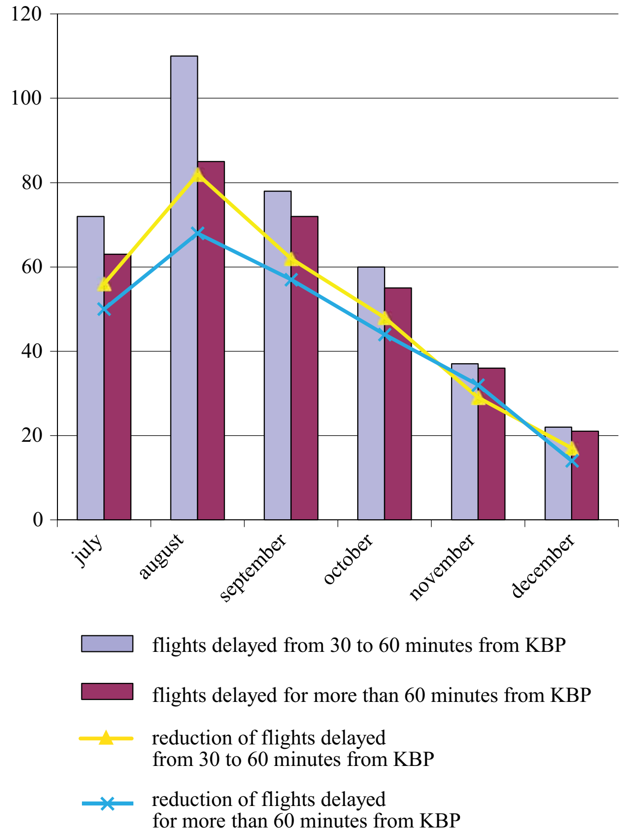

Fig. 3. Effect of simulation approach application on delays reduction for UIA from KBP

Application of simulation model would reduce departure delays and frequent changes in operations. Thus letting airline safe revenues and not waste money because of unused resources. The reduction of delays is represented in Fig. 3.

The Fig. 3 shows effect of simulation approach application on delays caused by different reasons for Ukraine International Airlines departing from KBP. The amount of delays is taken as an average according to previous 3 operating years of the airline. There are different reasons for aircrafts departing and arriving late. These can be air carrier delays, aircraft arriving late, security conditions, national aviation system, weather conditions, etc. Maintenance activities represent around 27% of delays of UIA at KBP. The Fig. 3 demonstrates possibility of delays' decrease after application of manpower simulation model for UIA.

Conclusions

1. In the result of using a simulation approach to manpower planning at Ukraine International Airlines' maintenance department the optimum number of workers has been determined.

2. Previously, the airline was using planning models which could not capture the peaks in arrivals and departures.
3. The used method allows the airline to minimize amount of unutilized manpower, therefore increasing efficiency of the maintenance department and minimizing labor costs.
4. The method allows to create an optimal working schedule for any day, week or month and to find out the reasonable amount of workers.
5. The model is capable to determine manpower requirements on a sub-shift basis, which is more efficient in staff utilization:
   5.1. The model allows utilize technicians with maximum efficiency, which was not possible before.
   5.2. In case of existence of a sub-shift with a low utilization level, it is possible to develop the idea to use part time technicians.
6. The model is flexible and adaptable to flight schedule changes and technicians requirements.
7. However, the existing model should be modified, which is subject to future research works:
   7.1. The model is adapted only to routine and planned checks.
   7.2. The model takes as input only one typical day of schedule.

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AVIAKOMPANIJOS „UKRAINOS TARPTAUTINĖS AVIALINIJOS“ TECHNINĖS PRIEŽIŪROS SKYRIAUS DARBO RESURSŲ PLANAVIMO MODELIS

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Santrauka

Straipsnyje pateiktas aviakompanijos „Ukrainos tarptautinės avialinijos“ techninės priežiūros skyriaus darbo resursų planavimo modelis. Problema nagrinėjama siekiant padidinti aviakompanijos padalinio ir pačios aviakompanijos veiklos efektyvumą.

Reikšminiai žodžiai: imitacinis modelis, modeliavimas, planavimas, darbo resursai, techninė priežiūra.