How Airline Dispatchers Manage Flights: A Task Analysis in Distributed and Heterogeneous Network Operations

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Equipped with technology, airline dispatchers interact with multiple entities to maximize the safety and efficiency of flights. How well the overall airline system performs is influenced by dispatchers' workload. In order to assist future work in developing advanced automated technologies to assist dispatchers, particularly under high-workload periods, this paper presents an analysis of airline dispatchers' tasks in a large operations control center. This is an important step in developing airline dispatcher workload simulations and other analytical approaches that assist in staffing of operations for dynamic operations, as well as estimating the impact of new technology on dispatchers' workload.

INTRODUCTION

Airline dispatchers (a.k.a, aircraft or flight dispatchers, flight operations officers) play a critical role in flight safety and efficiency regarding flight scheduling and operations. Individual workload indicates performance and wellbeing (Cain, 2007) and may be affected by many factors in the work environment, including the introduction of new technology and interactions with a number of parties to deal with various issues. Understanding how potential influencing factors contribute to dispatchers' workload can guide the development and implementation of assisting automation appropriately (Laughery, Lebiere, & Archer, 2006). However, few have studied airline dispatchers' workload in detail.

The goal of this paper is to identify airline dispatchers' main tasks for ultimately developing an airline dispatcher workload simulation, using discrete event simulation (DES). DES models the task flow and distributions to create stochastic estimates of dispatcher workload during a work shift and has been shown to be useful in diagnosing automation function allocation and estimating operator workload in a variety of environments (Huang, Cummings, & Nneji, 2018; Jun, Jacobson, & Swisher, 1999; Luo, Zhang, & Liu, 2002; Nneji, Cummings, & Stimpson, 2019; Stimpson, Ryan, & Cummings, 2016). To this end, we investigated airline dispatchers' work contents and work procedure through a set of field observations of dispatchers' work and subject matter expert (SME) interviews, guided by the following questions:

1) What kind of tasks do dispatchers do?
2) How frequently do these tasks happen?
3) How long do these tasks last?
4) Who do dispatchers interact with to complete the tasks?
5) How do these interactions with other entities influence dispatchers' workload?
6) What kinds of tools do dispatchers use on tasks?
7) Are there any topics or issues that stand out?

METHOD

To determine the workflow and the type of tasks of airline dispatchers, two researchers conducted field observations over three days at a major commercial airline operations control center in the U.S.

On day one, the researchers interviewed people in the following roles to gain an introductory understanding of airline operations: dispatch instructor (staff A), information technology (IT) systems manager (staff B), IT dispatch software developer (staff C), and fleet manager (staff D). Staff A was a career dispatcher and gave the researchers a "crash course" into airline dispatcher functional requirements. Staff B gave the researchers a tour of the operations center and introduced the departments that surround and interface with dispatchers' work. Staff C introduced the software this airline company uses internally, and Staff D briefed on the interface and function of the fleet manager position. The researchers completed the day by observing two dispatchers of domestic flights for two hours, each during their evening shift.

On day two, the researchers audited in the airline operations command room during their daily 9am system call with all airports and internal departments. Managers and representatives from each department and station updated the status and anticipated conditions of their operations critical to the network performance. A special assignment supervisor for domestic flight control (staff E) later shared how he assigned flights and distributed workload for each dispatcher desk. The two researchers respectively observed two dispatchers supervising international flights for two hours during their morning shift. On the third day, one researcher continued to observe two additional domestic dispatchers at work for two hours each during their morning shift. The following sections present information gathered from the interviews and observations.

Dispatch Operating Environment

This large airline organization has over 800 aircraft and 5000 flights daily. Their dispatch center has up to 100 dispatchers to be responsible for all the flights. But these dispatchers are not responsible for the organization's six additional regional carriers because the regional have their own operations control center (OCC).

Each dispatcher supervises flights in a few geographical divisions. The mission of a dispatcher is first to ensure safety and then to optimize the flight schedule for maximum efficiency. Dispatchers have the authority to delay, divert, or cancel flights. Customer service is the highest priority of flight attendants, but dispatchers help coordinate many services for flight attendants and passengers. An important indicator of an airline company's performance is the percentage of completed flights; sometimes when an aircraft malfunctions, dispatchers

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will fly another, empty aircraft to its destination to ensure passengers will have a return flight on the promised route.

Task load Assignment

Each domestic dispatcher is usually responsible for 30–45 flights across the U.S. during their 9–hour shifts (max. 10), with 15 to 20 flights in the air at any moment. The international dispatchers, on the other hand, each manage only four to 20 flights in their region, with an estimated average of eight flights per desk. Each desk is handled by one dispatcher. The task load is normally evenly distributed across all dispatchers, but in the event of irregular operations, the workload can spike for individual dispatchers. According to the companies' standard, handling 40–42 flights is an indicator for high workload, and 45–48 flights are difficult for a single dispatcher to manage safely and efficiently.

The task load assignment of dispatchers depends on (1) the varying levels of traffic in the region; (2) weather conditions; (3) trip duration (e.g., short and repetitive domestic trips vs. long-duration international trips); (4) flight time of day (afternoon shifts are the busiest because the weather is most likely to change in the afternoon); (5) the number of flights to be released in a small time window; and (6) the number of cities to watch during a shift. A scoring system was developed to rate each flight on these six factors and to calculate a dispatcher's aggregated workload.

Key flights are always assigned to the same desks, but some flights change schedules on a regular basis. Therefore, the domestic flight control manager works on a monthly basis to update domestic flight dispatcher assignments manually. One to two desks are not assigned fixed flights to allow flexibility so that dispatchers on these desks are available to offload any flights from other dispatchers when needed.

Airline dispatchers usually work nine hours per day and should not exceed 10 hours. They do not have scheduled breaks but eat meals at their desks and take personal care time when possible. When a dispatcher is overwhelmed in extreme conditions, the chief dispatcher may oversee the situation and reallocate some flights to other desks.

Dispatchers seated in a quad arrangement may also help each other in hectic cases, such as assisting the busy dispatcher in pulling information from handbooks about airport instructions from the internal website of the organization.

Dispatch Operating Rules and Background

Dispatch functions are highly regulated. Dispatchers undergo training per Federal Aviation Regulation (FAR) Part 65 for 200 hours (six weeks), including regulations, navigation, emergency/abnormal conditions, and aircraft performance. Then, dispatcher candidates sit with a Federal Aviation Administration (FAA)-certified instructor to take a test. After they pass the test, they receive customized FAR Part 121 in-house training with operation specifications, including airline-specific computer systems, regulations, and exceptions. During a 4-hour classroom test, trainees demonstrate knowledge, procedures, and their ability to make good decisions. After the tests, they also work on two full shifts monitored by a senior dispatcher. When candidates have satisfied all these requirements, they are signed off to dispatch independently. Independent dispatchers still have yearly classroom evaluations. Since dispatchers are trained to handle a wide array of issues and they also use the same tools to interact with multiple parties, dispatchers may change positions when they qualify or help other dispatchers when needed.

For the past 25 years, most dispatchers have been hired with no experience, rather than as transfers from other airlines, so unique cultures and sets of assumptions have evolved within each airline. For example, dispatchers develop their own thresholds for fuel allocation. Dispatchers may also execute tasks differently because of their differing personalities and experiences. However, they all must operate within the same regulatory requirements.

Participants Observed

Six dispatchers (5 male, 1 female) were observed in this case study. Four dispatchers managed domestic flights, and two of them operated international flights.

FINDINGS

Dispatchers coordinate all the services and preparations required to ensure the aircraft depart and arrive safely and on schedule. Dispatchers interact with multiple teams via communication technologies to ensure the safety, efficiency, and satisfaction of the flights and passengers, as summarized in Figure 1. Interactions refer to dispatchers' observable work-related actions.

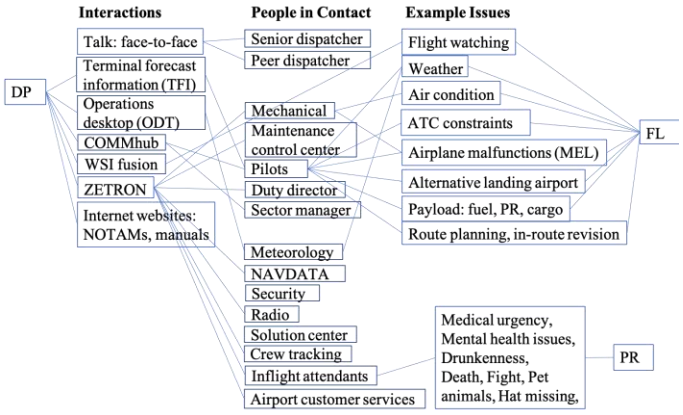

Figure 1. **Airline dispatchers' work analysis (*Note.* DP = Dispatchers; FL = Flights, PR = Passengers; lines indicate connections).**

Dispatch Operating Tools and Interactions

A typical dispatching desk in this organization includes four monitors (Figure 2), which consist of a set of tools to do various tasks. The tools are listed below:

Terminal Forecast Information (TFI) is an old computer system that includes all historical information about all flights and embedded functions (e.g., checking the weather, exchanging messages with pilots). The terminal forecast information system is gradually being replaced by ODT and COMMhub, as described below. TFI is shown on the first screen from the left.

Operations Desktop (ODT) is a flight planner with detailed information about each assigned flight. The duty roster is the most frequently used tab that shows a dispatcher's

assigned flights and the flights' status. The flight information was listed in a table format for comparison and tracking. ODT has most information that a dispatcher needs to do flight planning, including a link to a message system called Aircraft Communications Addressing and Reporting System (ACARS). ODT also has a tab for pop-up alerts. Dispatchers need to attend to alerts and remember to confirm the alerts after resolving each one; otherwise, the alert window will pop up again as if not resolved. The ODT is shown on the second screen from the left.

Figure 2. **Standard dispatcher workstation and operating tools.**

COMMhub is a new system that enables dispatchers to exchange messages with all relevant parties. The tool is available to use for a few months and meant to replace the old communication system, TFI, but dispatchers are used to TFI, so the transition will take a few months or even longer. COMMhub is not displayed in Figure 1 but was demonstrated on the first screen from the left.

WSI fusion is a proactive operation manager, using a flat map to show the real-time information of the flights. WSI fusion provides visual representations of the flights and their routes, allowing dispatchers to watch the flight intuitively. WSI fusion is shown on the third monitor from the left.

ZETRON is a console for phone calls and radio and typically shown on the first monitor to the right. The speaker system is not a headphone, but an old-fashioned hand-held phone placed on the desk.

Internet websites. Internal website stores manuals and handbooks dispatchers need for their work, including Dispatch Resources Management (DRM), dispatch handbook (DRH, e.g., procedure books and any ATC layout and instructions). External websites, like FAA, show Notices to Airman (NOTAM), which are notices containing critical information for airline operations but was not delivered ahead of time through other means.

Dispatchers communicate with other departments through text messages (TFI, COMMhub, and ACARS), phone calls and radio (both through ZETRON). Each communication approach has its advantages and disadvantages (see Table 1). Dispatchers' messages to pilots are usually frequent, free format, and communicated two ways. The solution for special messages, such as asking for feedback and confirmation, is to repeat on the radio, "do you copy?" 1–5 times during a course of communication.

People in Contact

Dispatchers interact with many teams of people for various services, which led to one dispatcher saying he communicates "literally any issue with anybody." The organization has 17 departments. Dispatchers interact with some departments more than the others. Examples include the following departments:

- The mechanical team at the maintenance control center (MCC) are experts on the fleet and provide information on broken pieces on the airplane on the Minimum Equipment List (MEL).
- Pilots-in-command (PIC) and dispatchers legally share the responsibility of the operational control of their flights. Pilots send information to dispatchers about the quality of their flights, which may be used to inform other pilots on similar paths. The pilots report position and remaining fuel at each waypoint to dispatchers and every 1–1.5 hours. Dispatchers update pilots with flight plans, in-route path revisions, weather information, and contingencies that may impact flight safety and efficiency.
- The internal meteorology team provides tailored and precise national and international weather forecasts for the company, including half-hourly forecasts, which are not available from the national weather forecast.

Other internal departments include maintenance coordinators, the security department in charge of corporate security, the duty director in charge of the facility, in-flight attendants, Airport Customer Services (ACS), the sector/system operation managers, the solution team, the radio crew, the flight control crew, the strategic planning team, the Navdata crew, and the management group. Examples of external interactions include air traffic controllers and local emergency medical services.

Table 1. Dispatchers' communication comparison

Approaches	Pros	Cons
TFI text messages	• Familiar • Effective over a long distance	• Lack of emotions • Lack of clarity of information
COMMhub text messages	• Friendly user interface • Combined with other tools and resources	• Lack of emotions • Lack of clarity of information • New system
ACARS text message	• Familiar; efficient • Directly connected to flight info. in ODT; • Best for oversea msg.	• Lack of emotions • Lack of clarity of information severity due to brevity
Phone calls	• Rich information with emotions and more description • Phone calls take less time than radio	• An individual is tied up on the call • The other party may not be available, so the caller needs to wait.
Radio	• Rich information with emotions and more description	• An individual is tied up on the call
In person	• A natural and easy way to talk, with most personal info.	• Not accessible for entities who do not work at the same location

Flight Contingencies and Inflight IROPS

Flight contingencies and inflight IROPS (Irregular Operations) are incidents and accidents. Dispatcher workload fluctuates greatly depending on the frequency of contingencies and inflight irregular operations. Meanwhile, the types of contingencies also differ between domestic flights and international flights. Sometimes, contingencies could be a combination of conditions. We categorize all issues under flight-related issues regarding the operations of flights and

passenger related issues (e.g., belongings, medical urgency, and behavioral issues) (Figure 1).

Task Priorities. Normally tasks are handled in chronological order. However, anything in the air (inflight) is given a higher priority than events on the ground. Also, issues that require a short time to fix are generally given a higher priority. Dispatchers constantly evaluate the priority of each issue and deal with the issues accordingly.

Frequency and Duration of Events

The frequency of events differs greatly depending on types of tasks. Dispatchers have difficulty estimating the frequency of each task because sometimes they multitask and are not aware of the accurate time duration. For example, a dispatcher communicates tough weather information with one pilot back and forth through TFI while checking the remaining fuel for two other flights on WSI and then calls an airport gate to hold the flight. Sometimes the frequency fluctuates greatly. For example, they may receive 3–5 calls on a good weather day and over 100 calls on a bad weather day. However, dispatchers provide a range and an estimated frequency better than a novice. For event duration, staff A estimated that experienced dispatchers take about one minute to review the flight approaching instructions of an airport and inexperienced dispatchers may take 3–4 minutes to do the same task. It takes 2–15 minutes to plan a domestic flight and 2.5–3 hours for planning an international flight.

Task Analysis for Domestic Flight Dispatching

We categorized an airline dispatcher's tasks into four general phases: (1) taking over a shift (preplanning), (2) planning a flight, (3) watching or following a flight, and (4) handing over when leaving the shift. When a dispatcher manages multiple flights, planning flights and watching flights may occur simultaneously by focusing on one task and paying divided attention to the other. Table 2 shows a domestic flight dispatching process, with a simplified version in Figure 3 focusing on the main tasks during a shift.

Table 2. Task analysis for domestic flight dispatching

1. **Taking over a shift** begins with the 15-20 min brief that the leaving dispatcher explains to the incoming dispatcher, including all the pre-conditions and issues requiring attention. Then the incoming dispatcher does the following tasks:
   - 1.1. Check the number of flights to be planned
   - 1.2. Check the number of flights that are inflight and their status, such as location and fuel consumption (e.g., the note "FLASK/1436/+1.4/34" explains the status of the flight, milepost, and remaining fuel)
   - 1.3. Check the number of flights that are in range (i.e., the plane is in the process of landing but hasn't touched the ground yet)
   - 1.4. Check any problems to be fixed, delays, the amount of fuel each current flight is carrying, and any broken items listed on the Minimum Equipment List (MEL)
   - 1.5. Wait for another 30 minutes to fully catch up with the pace before making any dispatching decisions
2. **Planning for a single flight.** When planning for a single flight from beginning to completion, a dispatcher needs to do the following subtasks:
   - 2.1. Click the Duty Roster tab
   - 2.2. Check the current weather and the forecast for all aircraft routes and destinations, such as the condition of wind direction and strength, snow, turbulence, storm (above, around, and cut the corner), fog, rain, visibility, and ice
   - 2.3. Check for broken items from the MEL, as almost every airplane has broken items.
   - 2.4. Check the flights' destinations
   - 2.5. Review the plans from the whole picture
   - 2.6. Arrange passenger payload
   - 2.7. Arrange cargo payload
   - 2.8. Arrange payload for required fuel (fuel for holding, fuel for taxing, 10% fuel from the airport to the first waypoint of the route, fuel for an alternative airport). Fuel is related to the weight of the aircraft, the power of the engine, and the number of passengers. Including an alternative airport may require a lot of fuel and result in a higher cost.
   - 2.9. Choose a good path. After clicking a flight, ODT system shows pre-calculated paths and corresponding cost values. Cost is determined by fuel, crew time, flight attendance, and trip time.
   - 2.10. Consider alternative landing airport and ensure the aircraft carries enough fuel to land at the alternative airport.
     - 2.10.1. Decide 45 minutes reserved fuel
     - 2.10.2. Decide contingency amount of fuel
     - 2.10.3. Decide when to add fuel
   - 2.11. Consider other potential problems
3. **Watching or following a flight.** The purpose of flight following is to provide relevant information to the crew that the crew could not see from their end, for example, real-time weather broadcast. Dispatchers' tasks during flight watching include the following:
   - 3.1. Watch the flight's route and altitude
   - 3.2. Make decisions on whether to return to the airport or divert to another landing airport due to not having enough resources (e.g., fuel, water)
   - 3.3. Watch whether the flight deviates from the planned route
   - 3.4. Check contingencies
   - 3.5. Respond to ODT alerts
   - 3.6. Check weather consistently
   - 3.7. Check fuel consumption for each flight
   - 3.8. Send new weather information to pilots
   - 3.9. Check airports, weather, MEL, and WSI fusion (for location) for potential problems
   - 3.10. Delete the flight from the Duty Roster tab once the flight lands
4. **Turning over a shift** happens in the last 15-20 minutes of a shift. The on-duty dispatcher still does the flight planning and watching but focuses on telling the next person about what to pay attention to, including the number of lights, fuel planning, and contingencies, and other items listed on the shift initiation process.

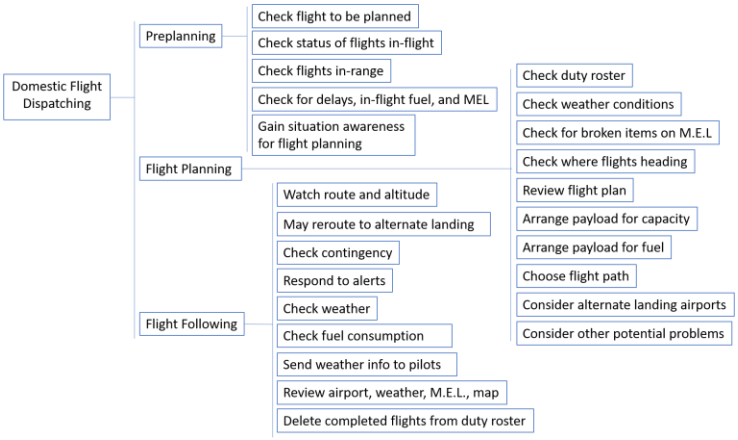

Figure 3. **Flow chart for domestic flight dispatching.**

Task Analysis for International Flight Dispatching

Different from domestic flight planning, international flights that are over six hours require an alternative landing airport. In addition, international flight dispatchers do a lot of re-dispatching planning to maximize fuel efficiency because carrying unnecessary fuel is costly. Fuel payload depends on the time in the air. Re-dispatching is done to evaluate the

weight of the remaining fuel and see if it is enough to follow the planned route or if it should stop at an airport to get more fuel. International flights are expected to be released 90 minutes before departure, so dispatchers need to check the departure time of the assigned flights to finish flight planning in time. Due to the complexity of planning an international flight, international flight dispatchers may only plan for four flights during one shift. For flights that last for more than 10 hours, a dispatcher who releases the flight may not see the flight land before turning over a shift.

For re-dispatching tasks, pilots and dispatchers are mutually responsible, and agreements are required on any change of plans. When dispatchers send out a re-dispatch command, the captain pilot may reply "RDA," meaning "Redispatch Accepted"; otherwise, the captain would report the situation.

The task analysis for international flight dispatching is similar to domestic flight dispatching, except for the additional factors that must be considered during planning and watching. Table 3 shows some examples of such contingencies.

Table 3. Examples of contingencies in international flight dispatching

• Checking political issues along the flight path (e.g., it is illegal to fly to Syria due to potential bombing)
• Checking long-range geological issues (e.g., turbulence and volcanic ash obstacles over the Pacific Ocean, fuel may freeze for being at high altitude for too long when flying on a long trip to South Africa)
• Checking air space cost, for example, Russia has a costly air space fee, so they plan the flight around it
• Checking other events to avoid conflict (e.g., Space X is going to launch another rocket in Florida)

DISCUSSION

Domestic and international flight plannings have similarities in the general phases: initiating a shift, flight planning, flight following, and turning over a shift. For all dispatchers, the most significant factor influencing workload is weather conditions. With nice weather, dispatchers have a relatively low workload. When there is turbulence, heavy snow, or other abnormal conditions, they have to plan differently (e.g., flight paths and payload) and communicate much more frequently with pilots. Modeling the impact of weather on workload is critical for dispatcher staffing.

Dispatching domestic flights and international flights also differ because the long length of international routes involves a greater variety of weather conditions, political issues, geographical issues, and higher requirements of flight path planning and related payload arrangement.

We categorized dispatchers' tasks as flight-related and passenger-related. The complexity of dispatching comes from the number of parties that dispatchers need to work with to coordinate all services to ensure the flight safety, efficiency, and economy, and to fulfill passengers' needs (e.g., contacting medical teams on the ground). Such tasks should be reflected in any model.

Among the tools used in the flight planning and flight following tasks, ODT and WSI played a critical role in aiding dispatchers' decision making. ODT provided pre-entered information about the flights (e.g., MEL, parameters of possible routes for dispatchers to compare and choose) and prompts alerts for attention. WSI assisted with flight planning by showing real-time flight routes and locations intuitively.

The interactions, tools, and issues provide a framework for data collection to develop the airline dispatcher workload simulation. The workload data could be collected through field observations by recording start time, end time, and interactions (Huang et al., 2018), focusing on the high-level interactions (e.g., working on ODT) rather than specific level (e.g., planning payloads for passenger and fuel in ODT). Additional data could be collected via rating workload for a list of identified specific tasks on a Likert scale.

Limitations

We learned and identified airline dispatchers' task types and procedure, but with limited data of frequency and duration of tasks. System log data is ideal but not available due to confidentiality constraints. Collecting observation data was labor intensive and also may carry subjectivity and potential observer bias. The findings are limited to one airline company.

Future Directions

The tasks, tools, and interactions reported above can inform data collection for developing an airline dispatcher workload simulation model. Next steps include (1) collecting dispatchers' rating on their workload for each task; (2) collecting observation data regarding the frequency and duration of the tasks during shifts, (3) building a data-driven simulation to predict extreme workload situations, and (4) suggesting additional automation tools to help adjust workload through information display and decision support.

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