Potential On-Time Performance Improvements at the Lufthansa Station at Frankfurt Airport

A Human Factors Approach

A thesis presented in partial fulfilment
of the requirements for the degree of

Master of Aviation

at Massey University, Auckland (Albany),
New Zealand

Joerg Speri

2006

Acknowledgements

At this place I would like to take the opportunity to thank the people who have helped me to write this thesis.

First of all thank you my tutors, Mrs. Karin Krestan, punctuality manager at the Lufthansa station at Frankfurt Airport, Germany, and Mr. Bernie Frey, PhD at the Department of Aviation, at Massey University, Auckland, New Zealand, who devoted some of their limited time, and assisted me with their guiding advice and assessments.

Moreover, special thanks to Mr. Jürgen Bier, Bastian Kraemer and Lovro Orajic, they are standing for all the colleagues at Lufthansa who helped me with useful inputs and advice.

I would also like to thank all Flight Managers, Assistant Flight Managers, and Section Leaders that participated in the survey. Their ideas and spirit are at the core of this thesis.

Also thanks to Lufthansa, who allowed me to do research at their station at Frankfurt Airport. Thanks to the station manager and his departmental managers.
And finally thanks to my friends who supported me during the process of writing this thesis and to my parents without their help none of this would have been possible.

Thanks to all of you

Abstract

Departure punctuality has increasingly gained attention over the last few years. This development is due to the realization what important role this issue plays in the economics of the airline industry. Punctuality is not just a sound performance indicator but also allows airlines to differentiate themselves from their competitors. In addition the issue holds a significant potential for cost savings.

For this reason many airlines have started special programmes to improve their punctuality performance, and so did Lufthansa. However, despite this increasing attention, outbound punctuality levels have not yet reached satisfactory levels. Therefore, this study aimed at contributing to this process by identifying potential on-time performance improvements at the Lufthansa station at Frankfurt Airport.

As an underlying framework, a Human Factors approach was chosen. Central issues in the focus of the study were the individual perceptions and attitudes towards punctuality by the relevant front line staff. In order to examine these issues a survey among the Flight Managers, Assistant Flight Managers, and Section leaders was carried out. The results of this survey were then put into correlation with the delay statistics published.

The results of the survey indicate a potential lack of communication among the front line staff as well as between them and higher organizational entities. Moreover, certain distrust towards the delay statistics became evident. Although the staff members seem quite well motivated, they feel a lack of commitment by their superiors. In addition, the survey gathered some interesting ideas for punctuality improvements held by the front line staff members.

Besides very concrete topics for discussion, the central outcome of the study was the recommendation to analyze all relevant processes at the Lufthansa station from a Human Factors perspective in order to improve the communicative situation. Moreover, the study suggests introducing appropriate incentive schemes in order to promote better on-time performance. Altogether these should result in a noticeable improvement of the punctuality situation at the Lufthansa station.

Table of Contents

Tables & Figures

Abbreviations & Operational Terms

A/C: Aircraft

AEA: Association of European Airlines

AFM: Assistant Flight Manager

APIS: Advanced Passenger Information System

ACARS: Aircraft Communications Advising and Reporting System

ATC: Air Traffic Control

Connex: Connecting

Cont: Continental

DASGO: Data Access for Ground Operations

Dom: Domestic

Df: Degrees of Freedom

etc.: et cetera

ex: coming from/ out of

FAA: Federal Aviation Authorities

FM: Flight Manager

FRA SE: department for the operative station control and management

FRA SO: department for the aircraft handling at the Lufthansa station at Frankfurt Airport – head: Mr. Rolf-Dieter Gettert

FRA ST: central department of the Lufthansa station at Frankfurt Airport – head: Mr. Andreas Döpper

FRA SV: department for the passenger handling at the Lufthansa station at Frankfurt Airport head: Mr. Markus Vaagt

GDR: German Democratic Republic – former East Germany

GSS: GepäckSortierSystem – luggage sorting system

HCC: Hub Control Center – special facility from where all operations at Frankfurt Airport are monitored and commanded

HFES: Human Factors & Ergonomics society

HON Circle: top customer program of Lufthansa – persons need to fulfil certain requirements to get admission to special lounges, terminals and unique services

IATA: International Air Transportation Association

Icont: intercontinental

LH: Lufthansa German Airlines

LSG: Lufthansa Service Gesellschaft – Catering subsidiary of Lufthansa

MANCOVA: Multivariate Analysis of Co-Variance

MCT: Minimum Connecting Time

Min.: Minutes

MIT: Massachusetts Institute of Technology

MS: Mean of Squares

N: Number

Participants: Part of the population that was actually available for the survey

PAX: Passenger

Population: Staff in the respective positions under investigation in this project (FM, AFM, SLSO)

Respondents: Part of the participants who actually returned their questionnaires

SARS: Severe Acute Respiratory Syndrome

Sig.: Level of significance

SLSO: Section leader at FRA SO

SS: Sum of Squares

ULD: cargo containers used in aircraft

U.S.: United States (of America)

USA: United States of America

VIC: highly valuable cargo – underlies special regulations

Preface

“A pro at the steering wheel”

By Ephraim Kishon “Best Driver Stories“ (2001)

(Translation from German by Jörg Speri)

People, who do not know the old Lustig better, think of him as a normal cab driver. In principle he is badly shaved, his eyes are ostentatiously red and swollen, because he intentionally does not sleep enough. When he walks, numerous car keys jingle in his pockets and if he sits, then just behind the steering wheel of his black cab. Strictly speaking Lustig is a cab driver indeed. However, this succinct definition does not nearly do justice to the facts.

De facto Lustig manages the international airport of Tel Aviv.

I found out about this through my own experience, when my car refused to start last week and I entered his cab, of all cabs, to get to the airport.

I was supposed to pick up a distantly related uncle of mine, whose arrival was scheduled for 7:30 am. “Don’t worry, stay calm” Lustig said as we came closer to the airport. “Lustig knows about how the things work. Which airline does your uncle fly?”

“As far as I know with Sabena.” ”And that’s why I had to hurry?” Lustig took his foot off the accelerator. “The flight will not arrive until 8:40. Thursdays Sabena is always 1 hour and 10 minutes late. Air France 25 minutes and TWA 1 hour and 12 minutes. Passport control and customs clearance won’t take too much time, as the local customs labour union committee will hold its every morning meeting. Your uncle will be a bit exhausted after the storm over Greece, apart from that, well and happy, although upset by the sour red wine that the slovenly air hostess has served him.”

“How do you know all that?”

“How Lustig knows about all that, he asks! Dear Sir, I have been driving to the airport for more than 40 years now. Today I am able to tell you everything about people just by looking into their faces, where they come from, how much money they have, and what they smuggle. One quick look and I know: 5 suitcases and a hatbox. I haven’t been out by more than one piece of hand luggage, never. Bear in mind, 40 years…”

We approach the airport. A guard wants to see my ID, by contrast he salutes Lustig.

“At the moment a lot of things are going on here” Lustig said “It’s because of the

numerous immigrants from Eastern Europe. You can experience a lot – some moments are really touching. Last Monday for example an old lady arrived who had not seen her daughter for more than 25 years. 25 years, Sir! They embraced each other for more than 10 minutes, laughing and crying at the same time…”

In this moment, a crowd of passengers comes out of the arrival hall. A young man is making his way through the crowd and rushes into the arms of a long bearded man – both break out in tears. Lustig is watching them silently. Then he says: “13 years!”

1. Introduction

1.1. Disposition

Chapter 1 introduces the setting of the thesis, and gives introductory information about Lufthansa German Airlines and the Lufthansa Station at Frankfurt Airport. Moreover, the problem under investigation is introduced; the assumptions and limitations of the work are presented, and the thesis is delimited from previous research.

Chapter 2 is providing the theoretical background and literature review of this project. First of all, general information about the theoretical background is given. This is complemented by a review of relevant literature about Human Factors science, airport and punctuality management from various perspectives. The chapter closes with a review of the theoretical literature about the research instruments used during this work.

Chapter 3 deals with the method and procedures applied in the research process. The chapter starts with a philosophical derivation of the overall research approach. The questionnaires used in the survey are presented and the progress of the research process is described. The chapter finally gives a critical account of the reliability and validity of the results obtained.

Chapter 4 is divided into two subchapters. The first one presents a detailed analysis of the punctuality situation at the station, on the basis of the delay statistics. The second one is concerned with the analysis of the outcomes of the survey among the staff at the station. Both sub-chapters provide the foundation for the further discussion.

Chapter 5 presents the discussion of the outcomes of the data analysis performed in chapter four. All major issues are scrutinized and put into relationship to each other.

Chapter 6 concludes the thesis and presents recommendations and implications derived from the discussion. Moreover, points of departure for further research are pointed out.

1.2. Introduction Lufthansa & Frankfurt Airport

1.2.1. Lufthansa German Airlines – a Journey down Memory Lane

Talking about Lufthansa's past actually means talking about two different companies. It also means talking about European - particularly German economic and political history. The following subchapter will provide a brief introduction to Lufthansa's eventful history – preparing the basis and setting for further discussion. As Lufthansa provides extensive information through its intranet web pages, this source was used for the majority of the information in this subchapter.

The "old" Lufthansa – the years from 1926 – 1945

At the beginning of the 20th century, only years after the Wright brothers' first motorized flight in 1903, aviation started to change the world. Already in the early 1920s, a remarkable number of aviation related companies had been founded. The aviation industry – aircraft manufacturers and early airlines – had turned out to be an engine for progress. Germany was one of the countries these developments started from. Soon a strong aviation industry built up. Big names such as Junkers, still well known today, appeared on the stage. Based on this background, it was only a matter of time until a first national carrier was born.

On 6th of January 1926 "Deutsche Luft Hansa Aktiengesellschaft" was founded – a merger between "Deutsche Aero Lloyd" (DAL) and "Junkers Luftverkehr". The new airline inherited its crane logo, designed by "Deutsche Luft Reederei" in 1919, from DAL, and the blue-and-yellow house colors from Junkers. The signatures under the corporate charter were set in Berlin's famous Hotel "Kaiserhof".

On 6th April 1926 the airline took off for the first time - serving eight routes which were supplemented during the following weeks. In the first year of operations, Luft Hansa aircraft flew 6,537,434 kilometres and transported 56,268 passengers, 946 tons of mail and freight. The company had 1,527 employees at this time. During the early 1930s the company experienced tremendous growth. November 1st 1932 was an

important date for the company – on this day Luft Hansa introduced the famous JU52 aircraft, better known as “Aunty JU” in Germany, on the Alpine Route. JU52 was the first whole-metal aircraft used for scheduled air transport and is still part of today’s Lufthansa fleet. The 3rd of February 1934 marks another milestone in the company’s history – Luft Hansa opened a new chapter in aviation with the initiation of a scheduled air-mail-service crossing the South Atlantic. And the history of introducing innovations had just begun. It was in June 1938 that the first stewardesses started taking care of the well-being of the passengers aboard Luft Hansa’s aircraft. Over the years the young airline extended its route network more and more – culminating in the introduction of scheduled flight services on a route from Berlin to Bangkok in 1939. This was the highpoint of the “old” Luft Hansa.

The next ten years would be part of the darkest time in German history. On August 31st 1939 just days before the beginning of World War II Luft Hansa suspended all its flight services. The flights were to be reintroduced later in September but the route network never reached its state of the pre-war times. As Germany had declared war on almost all the countries Luft Hansa was serving, just a few routes to neutral countries were left. A further setback for the company emerged when the longer the war took, the more engineers, pilots, and aircraft were called up for military service. These developments came to a heed in 1944 when almost no aircraft was left to be in service for civil purposes. Following the surrender in 1945, the manufacture, ownership and operation of aircraft in Germany was generally prohibited – therefore the surrender of Germany also marked the fall of the “old” Luft Hansa. In 1965 the company was finally erased from the Berlin commercial register. A remarkable part of aviation history had come to an end.

The “Deutsche Lufthansa AG” – a new beginning from 1953 to now

The history of the “modern” Lufthansa dates back to the early 1950s. In 1951 a committee was set up to prepare for the resumption of air traffic in postwar Germany. A new company to run air services and named "Aktiengesellschaft für Luftverkehrsbedarf" (Luftag) was founded in Cologne on January 6, 1953. The company changed its name to the more traditional "Deutsche Lufthansa

Aktiengesellschaft" in 1954, and resumed scheduled flights on April 1, 1955. Just ten years after a devastating war that had changed the world like no other, Lufthansa took off again with a fleet of short- and medium-haul and four long-distance aircraft. Just one year later Lufthansa had transported more than a hundred thousand passengers. By 1959 the network had expanded to almost 93000km and about 786000 passengers that year. Once again Lufthansa was experiencing a phase of extraordinary growth. Its services were well recognized again and were regarded as exemplary.

At the end of the 1950s the first jet-engine aircraft were bought and from the 1960s the legendary Boeing 707 was serving Lufthansa's long haul routes. The dawn of the jet era brought a first restructuring phase to the company as the route network was adapted to the new faster and longer range jet aircraft. Until the end of this decade Lufthansa experienced steady growth culminating in 1969 with an 18% upturn. The 26th of April 1970 marked another remarkable step in the history of the airline – the introduction of Boeings 747 "Jumbo-jet" on the routes from Frankfurt to New York and Asia opened a new era of flying. The oil crisis in the mid '70s and the following developments in the world-economy made it increasingly hard for Lufthansa to succeed. Nevertheless, due to outstanding management decisions the crisis was mastered before the end of the decade.

The 1980s increasingly changed Lufthansa into a more service-orientated organisation. With the modernization of the fleet the company enjoyed stable growth and relatively calm years. At this stage the airline began to cooperate with other airlines to provide its passengers a richer variety of destinations all over the globe.
The reunification of Germany in 1990 was a chance and a challenge for Lufthansa at the same time. While being allowed to fly to Eastern Germany for the first time since its foundation and while winning new markets in Eastern Europe, the company had also to deal with the burden of the former German Democratic Republic's (GDR) past aviation industry. This process was negatively affected by the first Gulf War which caused a drastic decline in demand for international air travel. It took the company until 1993 to master the crisis. In the same year Lufthansa signed a first contract over

cooperation with United Airlines – this can be considered as the first step towards the foundation of the Star Alliance.

During the 1990s Lufthansa started to found a number of aviation – related companies apart from their core business. Among them is Lufthansa Technik, the world's leading provider of aircraft maintenance and overhaul services. Furthermore, Lufthansa Service Gesellschaft (LSG) is the largest airline caterer in the world. Some of these companies have become leaders in their markets and contribute very much to the success of the Lufthansa Aviation Group.

September 11th 2001 marked one of the worst days in the aviation history to date. In the middle of an already existing worldwide crisis, the airline industry and with it Lufthansa, was hit without warning. The devastating terror acts of September 11th caused a cut in worldwide air travel demand never experienced before. Nevertheless, by implementing comprehensive cost and capacity measures the company was able to successfully deal with the crisis. Contrary to the USA and most other European airlines, at Lufthansa no mass dismissals were considered necessary. Before the company recovered fully, it was hit by the effects of the Severe Acute Respiratory Syndrome (SARS) crisis in early 2003 and later that year suffered from the new war in Iraq.

Today the company is facing new challenges, such as extremely high kerosene prices, a very competitive market environment on the European market with the rise of the no-frills carriers (e.g. Ryanair, Easy Jet), and finally economic pressure on the long-haul routes from other consolidated European carriers (e.g. Air France & KLM) and the uprising competitors from the Middle East region (e.g. Emirates, Qatar Airways). Besides, Lufthansa is currently also working on the settlement of the merger with SWISS International Airlines. Altogether, these developments will certainly require continuous change and adaptation, a process challenging any organisation (Lufthansa, 2005).

Following this brief historic overview the next chapter will present the Lufthansa Station at Frankfurt Airport, central hub of the "Lufthansa world" and setting for this specific research project.

1.2.2. FRA ST – the Lufthansa Station at Frankfurt Airport

As Frankfurt Airport is the central hub and basis of the Lufthansa network, the station at this airport is of outstanding importance for the airline. With about 2900 employees the station as such is larger than the total number of employees of some of the competitors of Lufthansa. The station offers wide-ranging services from passenger handling to aircraft handling.

Concerning passenger handling, the station provides all sorts of services from ticketing, lounge operations, to special services for handicapped passengers or care for unattended minors. A very special service is the unique Top Customer Service that Lufthansa established just about a year ago. First Class passengers and special HON Circle members are attended to in a separate top customer terminal that is more like a five star luxury lounge rather than an ordinary airport terminal. This list could be extended much further.

Regarding aircraft handling, the station is closely working together with the airport owner FRAPORT. It offers services such as ramp agents, baggage handling, weight & balance, and load control. Although Lufthansa as an airline has outsourced major parts of this business, it is still keeping the above mentioned key services alive.

All the above mentioned services are not just offered to Lufthansa and its Regional airline Lufthansa CityLine but also to customer airlines. About forty airlines use the handling services of Lufthansa for their operations at Frankfurt Airport. A sample of them is represented in Figure 1.

Figure 1: Airlines handled by Lufthansa at Frankfurt Airport (Lufthansa, 2005)

To give the reader an impression of the dimensions of the operation, the following figures will be useful: The Lufthansa station at Frankfurt Airport is responsible for the handling of about 400 continental and domestic departure flights each day. On top of this the station handles about 70 intercontinental flights each day. Altogether, this adds up to about 56000 passengers per day on average; in peaks up to nearly 70000. Approximately 7250 guests visit the lounges day by day. About 1100 passengers get special assistance and care every day (e.g. handicapped persons). Some fun facts in this regard: the Lufthansa station sells 108800 litres of beer each year, 20240 pounds of coffee are scalded every year, and finally, more than 90000 showers are taken in the lounges yearly (Lufthansa, 2005).

These figures become even more impressive if one takes into consideration that the operation takes place on a relatively crowded hub with limited infrastructure availability. The terminal used by Lufthansa dates back to the early 1970s and is basically running close to or above maximum capacity day by day. The same goes for the 2.5 runway system of the airport. Each factor alone would be critical; in sum they create a very challenging and complex environment for sound operations. In

order to better visualize the airport please refer to Figures 2 and 3 which include a map of the airport as well as a collage of images of Frankfurt Airport.

As a last point concerning the airport itself, a brief outlook to the future developments at the airport will be given. As Figure 2 shows, the airport is planning major construction and extension work. In particular, the new landing runway will provide urgently needed capacity. Moreover, a new terminal at the place of the recently abandoned US airbase in the very south of the airport area is planned. And finally, major adaptation is needed in order to allow the airport to be served by the new Airbus A380 “Superjumbo”. Following this, Lufthansa is also placing its maintenance and overhaul base for the new aircraft at the airport. Frankfurt will therefore become one of the major hubs in the network of airports used by this aircraft of new dimension (Fraport, 2005).

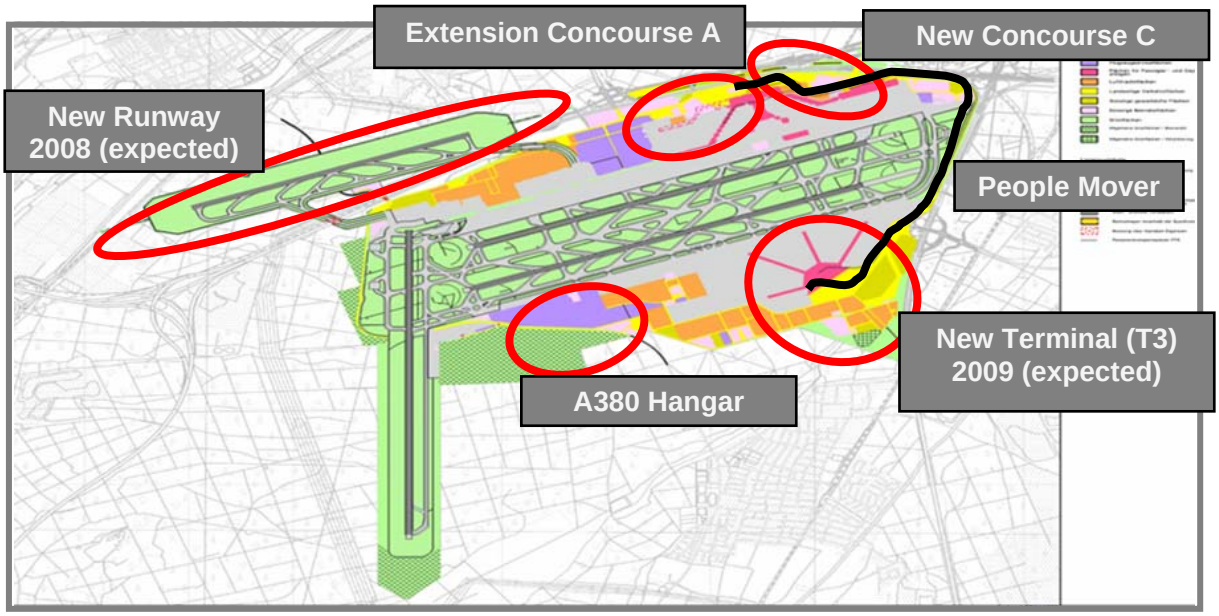


Figure 2: Extension Plans at Frankfurt Airport (Fraport, 2005)

Terminal 1 Concourse B (East & West)

Aerial View of Terminal 1 and Terminal 2

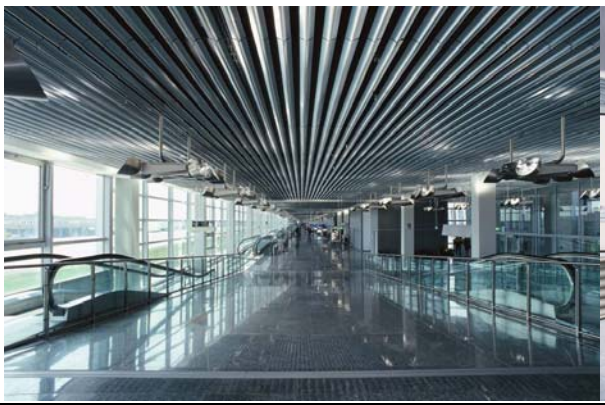
Frankfurt Airport Aerial View

Terminal 1 Concourse C and Terminal 2 (from the left)

Lufthansa Aircraft at Terminal 1 (Concourse A)

Hub Control Center (HCC) at Frankfurt Airport

Inside Terminal 1 (Concourse A)



Inside Terminal 1 (LH Gates at Concourse B)

Figure 3: Views of Frankfurt Airport (Lufthansa, 2005)

To run such complex operations under these circumstances a sound base organization is of central importance. For this reason the station is organized into five departments, each responsible for a very specific field of operation.

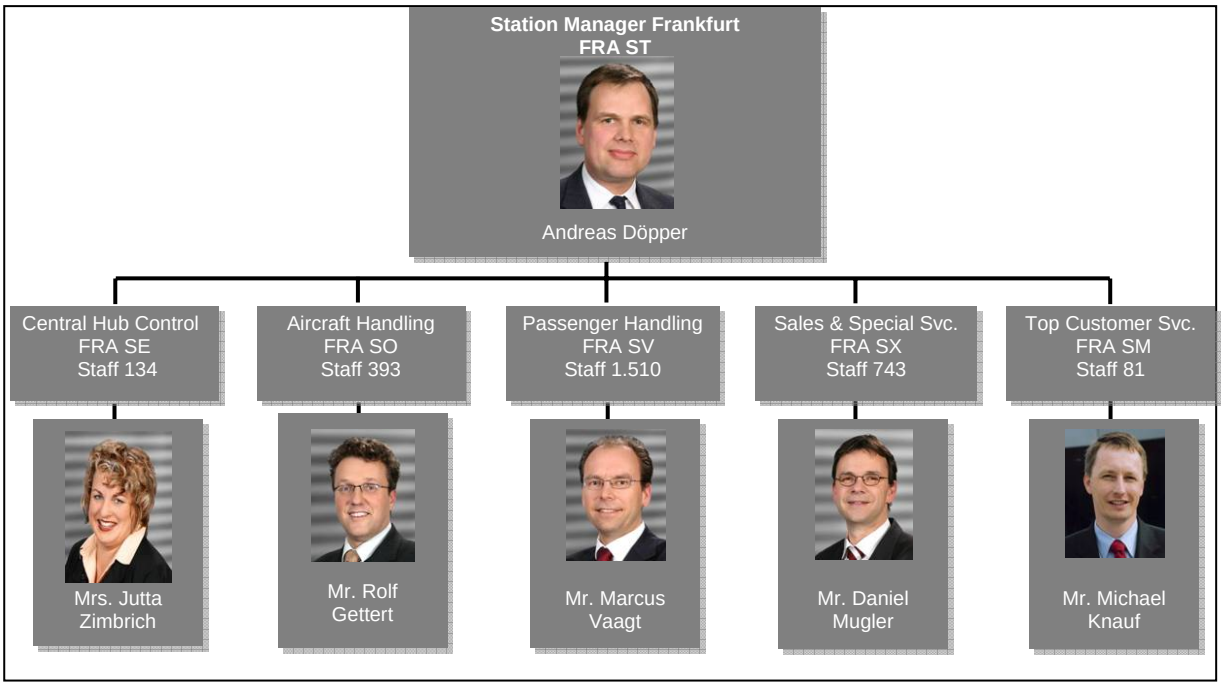


Figure 4: Lufthansa station Frankfurt – Organization chart (Lufthansa, 2005)

Figure 4 shows the organizational structure of the Lufthansa station including the pictures of the departmental managers as of December 2005 (Lufthansa, 2005).

Of specific importance in this regard is the department Central Hub Control that is responsible for running the so called Hub Control Center (HCC). To speak in naval terms, this Center is the bridge of the hub. From here, all daily hub operations of Lufthansa and its partners are controlled, supervised, and managed. A closer description of this Center will follow in the next chapter.

Concluding this chapter, one can say that the Lufthansa station at Frankfurt Airport is the one of the very central parts of the airline, responsible for a major amount of the operations. As the later chapters will show this is a very challenging task.

1.2.3. The Aircraft and Passenger Handling Process in Frankfurt

The aircraft and passenger handling is a complex logistical process. Various streams, soft- as well as hardware, need to be coordinated and delivered on-time in order to “produce” a punctual departure.

Figure 5 shows the “Reference Model” for the handling of intercontinental flights operated by Lufthansa from Frankfurt Airport. From this chronological table all sequential steps in the various streams can be derived. All employees involved in the processes are trained according to this model. However, this model, like any other, just reflects a simplified image of reality. There are several processes not included, nor are there any communication processes represented.

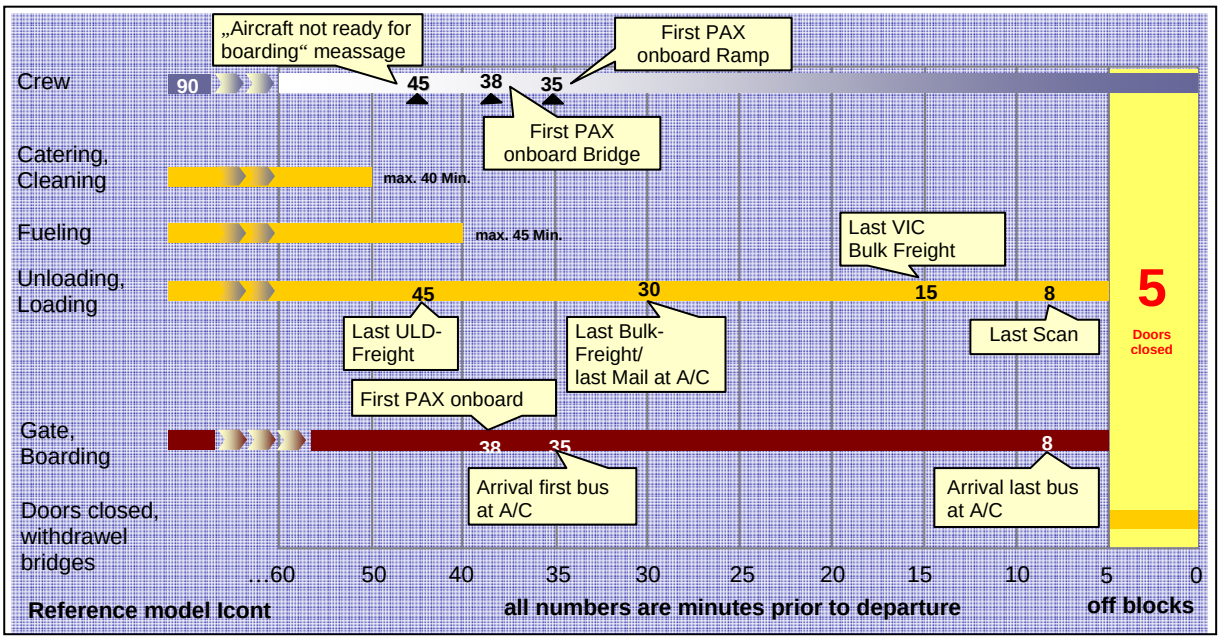


Figure 5: Reference Model for the Ground Handling (Lufthansa, 2005)

The model is based on experimental measurements and field studies. It is undergoing constant change and adaptation. However, it is not undisputed as reality has shown that some of the underlying assumptions are critical (e.g. time for closing the flight, time for boarding process, etc.).

Nevertheless, the model has proved its usefulness in the daily routines. Each partner involved in the handling process is working according to it, which brings us back to the Hub Control Center mentioned in the previous chapter. As said before, the HCC represents the bridge of the hub. The overall aim of setting up such a center was to improve the communication and information flow on the hub by putting all relevant players together in one room. Therefore, all major players in the handling process have manned workstations there. The HCC is also the hub of the communications system at the Lufthansa station. Through computer networks a flood of incoming information from various subsystems is filtered and provided to the process owner responsible. Before, information had to be transferred by means of telecommunication or radio, sometimes parallel or overlapping, however often time-consuming. Today all information is shared instantly. Nevertheless, this institution is not free of mistakes either and as the later discussion (see chapter 5) will show there is room for improvements (Lufthansa, 2005).

It is now necessary to introduce two of the major players in the handling process as they will be of critical importance for the research process. They are the central managers of the passenger respectively aircraft handling processes.

Flight Managers play one of the most important roles in the daily operational management at Frankfurt Airport. They have the task to independently control, monitor, and supervise all passenger and aircraft handling processes concerned with the flights allocated to their teams within their shifts. This includes processes such as loading, catering, boarding, seat allocation, check-in and many more. The overall aim of their duty is to ensure a safe, punctual, and customer friendly service at the airport. As supervisors, they have to lead their teams of 8 to 10. It is also their task to monitor and if necessary, improve the performance of their teams. Flight Managers also have to deal with all administrative work which results from their operational duties.

In order to ensure a high quality service, Lufthansa has developed a set of strict requirements one has to fulfil in order to become a Flight Manager. Besides long working experience in the field of aircraft- and passenger handling, candidates must have distinct qualities in the fields of personal organization, personnel leadership,

and working in highly complex environments. These requirements are complemented by further soft skills such as self confidence and appropriate appearance. To ensure the suitability of a candidate, a specially designed psychological test has to be passed by each applicant (Lufthansa, 2005).

The Assistant Flight Managers play a similar role to that of the Flight Managers. Their task is to support the Flight Managers. They independently perform the tasks as described above – however, just for the flights allocated to them by their Flight Manager. In order to do so, similar requirements are set for this position. Usually the position of Assistant Flight Manager is a waypoint on the way to become a Flight Manager (Lufthansa, 2005).

The second group I would like to mention in this regard are the Section leaders at FRA SO. They have a similar position to the one of the Flight Managers on the aircraft side of the handling process. Their central task is the supervision of the aircraft handling process. This comprises the leadership of their teams who are dealing with issues such as weight & balance, fuelling, or apron surveillance. Section leaders usually work in shifts as well. In order to perform well, Lufthansa has developed as set of skills and characteristics a candidate needs to fulfil. This includes long working experience in the field, technical knowledge, and a sound qualification in the corresponding procedures. Moreover, candidates must have distinct qualities in the fields of personal organization, personnel leadership, and need to be able to work in high complexity environments. Of course it is also compulsory for them to handle all administrative work concerned with their tasks (Lufthansa, 2005).

1.3. Statement of Problem

In times of constantly rising passenger numbers, crowded hubs have become a major issue in the aviation world. Similarly to logistics, seamless travel is becoming more and more important. Therefore, punctuality has become a major indicator of the quality of an airline. A high punctuality performance enables the carriers to differentiate themselves in a more and more competitive market environment.

There are two related perspectives on this problem. From passengers' points of view, on-time inbound performance is of central interest as the punctual arrival at their destination is within their focus. From an airline's point of view, the importance of on-time outbound performance is increasing as studies have shown (Niehues et. al., 2001) that the tying up of resources due to departure delays has become a major cost issue.

The major problem under investigation in this thesis will be the level of departure punctuality on long-haul flights operated by Lufthansa ex Frankfurt Airport. As this thesis will show, there are various reasons perceived and actual shortcomings in this area of performance – internal and external ones. This issue causes numerous further problems for the network system of the airline, inconvenience for the passengers, and by far most important, tremendous delay costs for the airline. Therefore the problem has a direct influence on the economic success of Lufthansa – from a short-term as well as a long-term perspective.

1.4. Significance of the Work

The overall aim of the work is to make a significant contribution to the management process taking place at the Lufthansa station at Frankfurt Airport in order to improve the on-time departure performance on flights operated by Lufthansa ex Frankfurt Airport.

From a scientific point of view the significance of the study is rooted in the application of Human Factors methods to a new field. Although Human Factors' methods have been applied in organizational research in business environments before, an application in process engineering, namely punctuality management is new and innovative.

Besides, as the later review of the relevant literature will show (see section 2.2), punctuality management as such, has to date received rather insufficient attention from researchers. The study therefore also aims to close this gap and help to conceptualize the problem.

1.5. Assumptions and Limitations

The study was locally limited to the Lufthansa Station at Frankfurt Airport, Germany. The overall time span of the research process went from March 2005 to August 2005, the time the researcher was on site. The actual survey was carried out from June 20th 2005 to the 31st of July 2005.

Survey participants were the Flight Managers, Assistant Flight Managers, and Section leaders of the Lufthansa station. A detailed description of the sample will follow in chapter three. Flights under investigation were departures ex Frankfurt operated by Lufthansa & Lufthansa CityLine.

Special focus was attached to the intercontinental flights. The study was further restricted by the availability and admittance to information due to company policies.

The central assumption of the study is the existence of something like an underlying punctuality culture as part of the overall corporate culture. This culture like any other is supposed to represent a set of shared attitudes and beliefs in a certain topic. Moreover, the study assumes that this culture can be measured by appropriate means. This existence of this culture is essential to this study as it marks the point of start for the change process to be initiated

1.6. Delimitations

Contrary to previous studies on on-time performance, this one is starting from an intra-organizational point of departure (e.g. de Neufeville and Odoni, 2003). While most studies start from a global perspective trying to avoid inner-organizational involvement (e.g. Niehues, et. al., 2001), this study aims at using the knowledge held by staff working in the frontline. Their experience and understanding of daily routines and processes are of central interest for this research project.

Therefore, the perceptions of the problems and shortcomings on the one hand, and the advantages of the current process design on the other hand, which is held by the relevant staff, will be within the focus in the research process.

Moreover, the study endeavours to find routines developed by the staff that are not part of the official process design but have proved to be useful in reality (best practices). In this regard the study distinguishes itself from approaches usually used by consultants, or researchers.

2. Literature Review and Theoretical Background

2.1. General Background

As the above introduction has shown, the operation of an airport is a rather complex thing to manage. The numerous sub-processes of the system need to be well designed in order to run smoothly – not dissimilar to the musicians of an orchestra. Only with a well designed arrangement, the “tones” will fit together to a piece of “music”.

When the researcher first came to Frankfurt Airport he thought that it was actually a wonder that this system performs well – at least to a certain extent – each day. Actually it was quite impressive especially as there was no obvious conductor apparent. To approach such a system from a theoretical perspective seemed to be at least as complicated as managing it.

A first look into the available figures and statistics showed that it was rather easy to measure the punctuality performance – however, the influencing factors became not as easily obvious. Therefore, the question arose how to conceptualize the problem and in the end, if not solve it, at least improve the situation.

As the problem under investigation in this study is concerned with complex system interactions, an organizational approach seemed to be advisable. However, the researcher’s choice was not only to use a traditional organizational approach but to apply a Human Factors perspective – a modern and widely accepted way (HFES, 2006).

The following subchapters aim at giving the reader the necessary theoretical background to the topic, and in addition deep insights about how the problem was tackled and conceptualized by the author. It will explain why this specific approach was chosen and how previous research has used it. Moreover, the chapters will present a theoretical account used during the research process.

2.2. Theory

2.2.1. Human Factors History

"…Human Factors, ergonomics, and engineering psychology are roughly equivalent terms for the field of science concerned with the optimization of the *relation between people and the machines* they operate through the systematic application of *human sciences* integrated in the framework of *systems engineering*" (Jensen, 1997)

The above definition already indicates what a wide field Human Factors science is. Nevertheless for the purpose of this study it is still too narrow as the course of the work will show.

Kim Vicente provides an even broader view on the topic that will be the basis of this research. In his work "The human factor: Revolutionizing the Way People Live with Technology" (Vicente, 2003) he widens the application of Human Factors to "systems" in general. For a detailed discussion of his book please refer to the following chapters. This chapter, however, aims at providing the reader with a sound understanding of the development of Human Factors.

Boff (2006) supports the opinion that Human Factors as a concept is nearly as old as mankind itself. He argues that the production and design of early weapons showed first evidence for the application of Human Factors. Of course the application at this early stage was of rather intuitive nature.

During the time of the early industrialisation first efforts were made in order to conceptualize ergonomics as a measure to improve worker efficiency and productivity (Jastrzebowski, 1857).

However, there is common agreement amongst today's researchers in the field that Human Factors as a science emerged from the systematic psychological research carried out during World War II (Smith 1987). The basis for the development of

Human Factors as a distinct field of research provided military aviation psychology which became more and more important throughout and after the war.

Roscoe dates the “birth” of the field back to early experimental studies carried out under the leadership of Sir Frederick Bartlett in 1939 (Roscoe, 1997). During the 1940s the US Army set up first programs for aviation psychology commissioning leading psychologists such as Arthur Melton, Frank Geldard, and Paul Horst (Koonce, 1984).

The central point of interest at that time was – how to select and test men capable of withstanding the forces and the stress of combat flying in a more and more accelerated environment. Men had to fit the machinery.

During world war two the Royal British Air Force as well as the United States Navy and Army experienced severe losses through “pilot errors”. Therefore a team under Lt. A. Chapanis was set up to investigate the reasons for these problems. Chapanis’ team soon realized that underlying reasons for the specific problem under investigation was the poor cockpit design resulting in faulty operation (Roscoe, 1997). Immediate changes in the cockpit design resulted in a clear improvement of the situation.

With increasing technological progress, engineers soon had to realize that the human being with its physiological and psychological characteristics had become a major limiting factor and source of error. Therefore, it attempted to test and find these limits in order to improve the human-machine-interface to enhance the interaction with the human being. This “physical fit” as it is attributed by Boff marks the first generation of Human Factors (Boff, 2006). Boff claims that there are four generations of Human Factors coexisting at present time, however being in different maturity phases (Boff, 1997).

As explained above generation one, which Boff assumes to be in its maturity phase is concerned with the “physical fit” aiming at adapting equipment, workplaces and tasks to the capabilities and limitations of the human being regarding physical

aspects such as power, size, etc.. It is this generation that is covered by the above mentioned definition of Human Factors by Jensen. Representatives of this first generation are Chapanis, Grether, Fleishman, and Kraft among others (Meister, 1999).

Generation two is concerned with the “cognitive fit” thus integrating the factors human being, technology, and work in such a way that enables systems to be effective. Contrary to the first generation this one is focused on cognition and systems, in particular on cognitive systems integration (Meister, 1999). This new widening of the perspective (Maurino et al, 1995) comprised the inclusion of the organizational, cultural, and systemic environment of the individual as a source of defining inputs for certain behaviours, actions, and decisions. It is also called ecological approach (Flach, 1995). The basis for this change was laid by Reason (1990). Central driver for the development of this generation of Human Factors was the increased complexity that arose from the introduction of IT-systems to a wide range of working environments (Rasmussen et. al., 1994). Key players of this generation are among others James Reason, David Meister, Jens Rasmussen, and Gary Klein. Boff (2006) considers this generation as currently being in its growth phase.

Generation three Human Factors is similar to generation two as it is also adopting a systemic approach. However, according to Boff generation three is “marked by a shift from building better work environments towards enabling humans to work better” (Boff, 2006). Contrary to generation two which was focused on cognitive fit, generation three is aiming to find a neural fit between equipment and the human central nervous system (Boff, 2006). The idea of a “cyborg” or bionic system, an enhanced human being by means of aiding or amplifying equipment to overcome the limitation of the human nature, is the central concept of this generation. This comprises implanted as well as external technologies. Boff (2006) considers this generation as to be currently emerging, however also referring to the fact that from a technical perspective many people, being connected to means like pacemakers, bionic joints or artificial limbs, are “cyborgs” in a wider sense already today.

Boff's fourth generation is at a very early stage of development that he refers to as "embryonic" (Boff, 2006). As the three previously mentioned generations, the fourth is also concerned with maximizing human effectiveness. However, generation four is trying to biologically modify human beings both physically as well as mentally by means such as advanced genetics or bio-molecular technologies (Boff, 2006). At present this generation of Human Factor scientists is focused on the application of pharmacology, bio technology, and genetics to slow down, reverse or modify the effects of disease or ageing. Sports doping is one of the negative outcomes that came along with the progress in this field (Eichner, 1997).

One can summarize the four generations briefly, as the first being concerned with building equipment or work spaces that fit the human body, while the second generation tries to develop working environments that fit the human brain. Both have in common that they try to alter the environment of the human being not the human being itself. Contrary to that generation three and four start exactly from this perspective – namely actively enhancing the capabilities of the human body. While the latter is approaching the human body from an intra-biological level the first is trying to reach the intended enhancements by combing the human body with technology.

The growing importance of organizational science in various fields but especially in business science and economics has brought impetus in recognition of Human Factors as well (Klein et. al., 1993). As the later discussion will show this study is aiming at finding a physical as well as a cognitive fit in the working environment at Frankfurt Airport. It can therefore be characterized as generation one and two Human Factors approach, however with main focus on generation two.

The wide spread application of Human Factors in various fields has led to a comprehensive preoccupation with the topic in academia (Roscoe, 1997). Following World War II the utilization of Human Factors specialists began to spread over the military to civil fields as well, including architecture, environmental design, transportation, medical systems, office automation, nuclear power plants, mining, oil field operations, and consumer products to name just a few (Roscoe, 1997).

Thousands of positions all over different industries were created. Therefore, the planning for a society to enhance the cooperation of Human Factors scientists as well as practitioners began in 1955. The Human Factors and Ergonomics Society (HFES) was then found on September 25th in 1957 in Tulsa, Oklahoma. 90 people attended this first meeting. Today there are about 4500 members in more than 50 chapters all over the world (HFES, 2006).

HFES aims at promoting the discovery and exchange of know how concerning the characteristics of human beings, which are applicable to the design of systems and devices of all kinds (HFES, 2006). Special attention is laid on systems performance; information presentation, detection and recognition; related action controls; workspace arrangement; and the required skills (HFES, 2006).

Since 1958 the society publishes two major periodicals: the Journal of Human Factors (quarterly) and the Human Factors and Ergonomics Society Bulletin (monthly).

This overview about the history of Human Factors science aimed at providing a sound basis for the further literature review. In particular there are two major works that will be examined closer as they will supply the underlying concepts for this study. The first is an article by Carayon (2006) from the Journal of Applied Ergonomics. The second is a detailed account of Kim Vicentes book “The Human Factor – Revolutionizing the way people live with technology” (Vicente, 2003) and his concept of “Human-Tech”.

2.2.2. Human Factors in complex sociotechnical Systems

This chapter deals with an article recently published by Pascale Carayon in the journal “Applied Ergonomics” (Carayon, 2006). Carayons article is based on Vicentes work from 1999 on work system complexity (Vicente, 1999). Carayons claims that the increasing work system complexity has a direct effect on the design, implementation and maintenance of so-called sociotechnical systems. He defines sociotechnical

systems as systems where technical as well as social or organizational factors form working environments for human beings.
Carayon adapted Vicentes dimensions of work complexity such as:

- Large problem spaces: defined by many different elements and forces (e.g. the number of different passengers at the airport and their complex problems)
- Social systems: defined by the composition of different people that work together
- Heterogeneous perspectives: from employees with various backgrounds
- Distributed systems: spatial division of employee and work (e.g. weight & balance center for Frankfurt Airport is located in Capetown, South Africa)
- Hazardous systems: safety and security issues at the airport
- Coupling: defined by highly interdependent processes such as the ground handling chain (compare Figure 5)
- Automation: defined by highly automated systems (e.g. the computerized check-in system)
- Uncertain data: uncertainty in data available to the employee (e.g. information from computer systems about the actual status of an aircraft)
- Mediated interaction: systems that are not directly observable by the employee (e.g. the baggage processing system for the gate staff)
- Disturbances: employees dealing with unexpected events (e.g. technical failure, wrong bookings, etc.)

According to Carayon there are two emerging trends at present: First the trend towards working across organizational, geographical, cultural, and temporal boundaries. Second an increasing role of the customer in product / service design.
Especially the first trend can be clearly observed in the working environment at Frankfurt Airport. It will therefore play a central role in the later discussion.

Friedman refers to this first trend as “flattening” of the world (Friedman, 2005). According to Carayon (2006) services and products are increasingly produced in processes including various entities or organizations that work together across

boundaries. This results in an increased number of interfaces thus amplifying the complexity of work.

From a Human Factors perspective these “complex sociotechnical systems” require a clear focus on all dimensions involved in the process (e.g. physical, cognitive, psychosocial, etc.) (Carayon, 2006).

This also means that system interactions become more and more important. Wilson (2000) claims that the nature of ergonomics is to understand people and their interactions, as well as the relationship between these interactions. However, his model of interactions is not the only one in this field. Also Rasmussen (2000), Moray (2000) and Smith together with Carayon (2000) among others have developed such models.

All these models have in common a perspective on work systems comprising the factors:

- Individual
- Technical work environment
- Organizational work environment
- External environment.

Moreover, especially Rasmussen and Moray put strong emphasis on the cross-disciplinary nature of such research thus demanding cooperation of Human Factors scientists with related domains such as organizational science, etc. It is this spirit that will also be guiding principle for this research.

2.2.3. The Human Factor – Kim Vicente

The review of the literature in the field showed that especially one author had conceptualized a broadened perspective in an easy to grasp way. In his book “The human factor – Revolutionizing the way people live with technology” Kim Vicente (2003) introduced his concept of Human-Tech. Central model of this approach is his

Human-Tech Ladder (Figure 6). The following paragraphs will introduce his idea as the underlying framework for this research project.

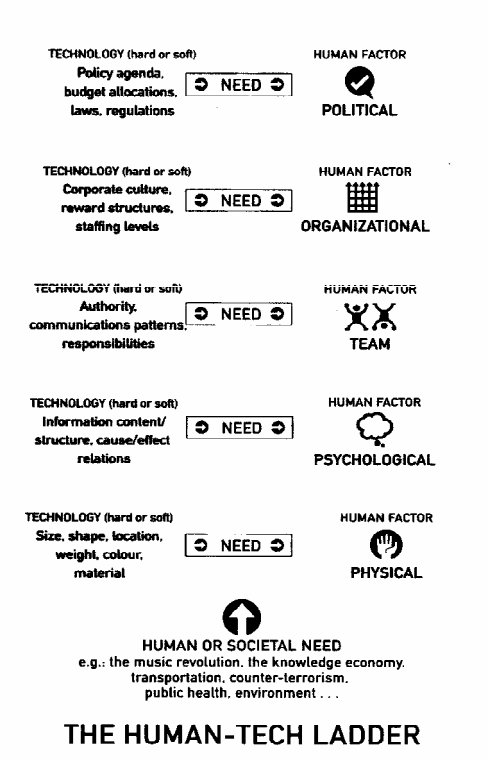


Figure 6: The Human Tech Ladder (Vicente, 2003)

Vicente defines five steps on his ladder which represent a hierarchical system of sub-factors that all together built up the human factor as a whole. In his model, higher factors require the fulfilment of the corresponding lower level demands. The overall aim of his concept is “to build a harmonious relationship” (Vicente, 2003, p.54) between technology and the human operator or user respectively, in order to raise the likelihood that the technology can fulfil its intended purpose. However, this view is not only limited to hardware systems and technology but also to organizational systems.

Moreover, Vicente broadened the view of Human Factors science from a man-machine focus to a man-system focus. He claims that from a Human Factors perspective all man-system relationships and interactions are subject to the same underlying concepts regardless of the nature of the system. Therefore, from his point of view an organization is not different from a machine – both need to be designed in

a way that the people working with them are capable of handling them. Consequently, the design of a working schedule, for example, is as important as the design of a joystick or lever of a machine.

At the lowest level of his ladder, ***physical*** requirements of a design are of interest. Vicente claims that at this lowest level, a design has to first of all fit the physical characteristics of the human body aimed at performing within that design. Dimensions of this sub-factor are for example: size, shape, location, weight, colour, and material (compare parallels to generation one Human Factors).

The second level applies a ***psychological*** perspective to the design of a given system. Vicente claims that keeping the psychological capabilities and limitations of the human being in mind when designing a new system is not just necessary but crucial. Factors such as the limited capabilities of human short or long-term memory as well as the limited capability of performing mental calculations or the capacity of pattern recognition, all these and many more – most of them well known and researched – should be taken into consideration at this stage.

On the third level a first external non-individual-based factor is introduced – namely the ***team*** perspective. As Vicente claims, the importance of this factor should not be underestimated. As today's working environment is largely organized in teamwork – interactions among the members of a team are of central importance. There is a wide range of factors that need to be taken into account on this level: team communications, team coordination, team interaction, and many more. Vicente explains that from his point of view; first of all an agreement about the common goal of the team is necessary in order to achieve the overall aim of any teamwork – namely synergistic effects.

Level four is concerned with ***organizational*** issues. As teams do not usually exist without links to their environment, their organizational embedment is of certain influence and therefore interest as well. At this level Vicente introduces concepts such as visions, leadership, incentives, disincentives, and intra-organizational information flow. To create affinity with people is the overall aim at this level. There

are various pitfalls waiting at this level causally emerging from human nature such as the human tendency to “shoot the messenger”, to still keep on going while it is actually already too late. These issues would not be as important if the decisions at the organizational level had not had such a strong influence on the lower levels. Decisions made at the organizational level have severe consequences for the whole system –Vicente provides the example of the working schedule which according to him is at least as important as the design of a switch or lever at a machine in order to run the system.

At the topmost rung of Vicente’s Human-Tech Ladder, ***political*** considerations need to be taken into account. These comprise issues such as public opinion, social values, and cultural norms. One could argue that these patterns or concepts have nothing to do with the design of a system as they are external factors. However, this is exactly Vicente’s point. He claims that these virtual factors which are rather hard to grasp and are definitely not physical, do exist and moreover, have strong influence on the functioning of all systems. As an impressive example, Vicente puts forward the laws of prohibition in the USA in the 1920s and 1930s. According to him, these laws mainly failed due to the ignorance of the societal value of freedom and self-determination. Vicente continues with a comparison that designing such a law under the given circumstances in the United States at the given time was the political equivalent of designing a technological system requiring the operators to lift three tons with their bare hands (Vicente, 2003).

Theoretical support for Vicente’s work comes from the field of Social Psychology. Commitment and organizational theory provide useful concepts for the understanding of the problem under investigation.

Organizational theory is concerned with the interactions within and between organizations. It can therefore be very helpful to understand and explain the interactions at the team as well as the organizational level of the human tech ladder. The roots of the field date back to the days of Max Weber. After the First World War, the focus of organizational studies shifted to analysis of how Human Factors and psychology affected organizations, a transformation propelled by the discovery of the

Hawthorne Effect. This Human Relations Movement focused more on teams, motivation, and the actualization of the goals of individuals within organizations. Leading theorists from the field are Fayol, Maslow and Herzberg.

Commitment theory is the last theory that is going to be presented here. This theory explains how attitudes (opinions, beliefs, ideas, and judgements) align themselves on behaviour (Freedman and Fraser, 1966). Commitment theory thus allows interventions on behaviour and attitudes, rejecting the assumption which has been amply invalidated in reality: in order to change behaviour, just change attitudes. Commitment theory provides evidence that people can be influenced in their convictions. Theorists claim that this is possible without applying force, authority, or even persuasion. Central concept of the theory is the freely consented submission (Beauvois and Joule, 2000). The idea behind this concept is to obtain, a priori insignificant acts that make people think about an issue and to change their future behaviour. Leading theorists from the field are Friedman, Fraser, Beauvois, and Joule.

Vicente claimed that Human Factors would revolutionize the way people live with technology (Vicente, 2003). His idea of a design process of any kind of equipment or work space taking human needs and behaviour into consideration at every level, will be the underlying concept of this research project. Vicente is a clear representative of generation two Human Factors. In order to further provide a sound theoretical understanding of the issue under investigation, the next subchapter provides a brief overview over the relevant literature on airport management.

2.2.4. Airport and Airline Management

Contrary to the subchapter above which presented the underlying framework for this specific research project, the following subchapter aims at giving a brief overview of the relevant standard airport and airline management literature.

There is a group of seven to ten authors among others who have had major influence on modern management in the aviation business. Contrary to authors of general

business literature, these authors specifically developed and applied new methods suitable for the special characteristics of the field of aviation management.

One of the most prominent representatives of this group is ***Rigas Doganis***. His two books “Flying Off Course – The Economics of International Airlines” (Doganis, 2002a) and “The Airport Business” (Doganis, 2002b) have become widely used standard literature most students of aviation management around the world are well familiar with. Doganis is a well known expert in the aviation business. He worked as a consultant and was also chairman of the Greek airline Olympic. Today he holds a professorship at Cranfield University in the UK.

The next author I would like to mention in this context is ***Stephen Shaw***. His work focused on airline management and marketing. His work on network structures and airline profitability has been widely accepted. Shaw’s most important work is certainly his book “Airline Management and Marketing” (Shaw, 2004).

Ashford, Stanton, and Moore are the next authors of the previously mentioned group. Their work on airport operations has helped to conceptualize the operation of an airport as no others have. All three are well recognized experts in the field. Norman Ashford is professor at Loughborough University in England and holds several chairs as a chartered engineer in various states in the U.S.. Martin Stanton was a qualified pilot and air traffic controller who worked for several airport authorities around the world – among them most interestingly for our case – for The Frankfurt Airport Authority, predecessor of today’s FRAPORT.
Finally Clifton Moore who looks back at thirty four years of experience in the airport business, and who was president of the International Civil Airports’ Association for eight years.

In their work “Airport Operations” Ashford, Stanton, and Moore (1997) have thoroughly examined all aspects of an airport from managerial as well as technological perspectives. However, most helpful for this specific research project are their models about the structure of an airport – physically as well as organizationally. Although these models represent very simplified views, they can

help to structure the very complex organizational systems airports are. The reader should bear them in mind as a helpful roadmap during the later discussion in this paper.

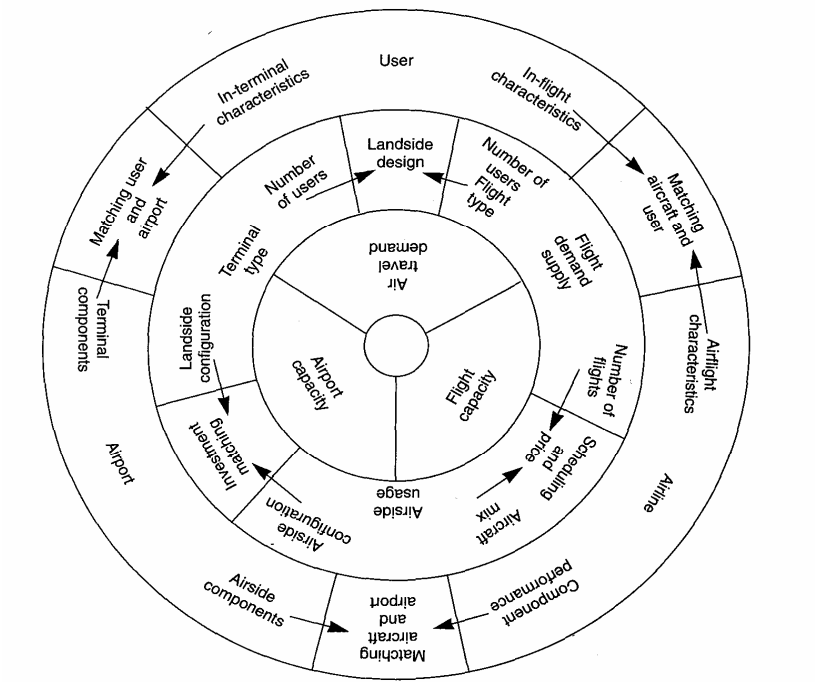


Figure 7: Model of Airport Relationships (Ashford, Stanton, and Moore, 1997)

Ashford and a former co-author have developed the above hierarchical model of airport relationships (Figure 7). It describes the fields of tension between the three major components of the air transport system (Ashford, Stanton, and Moore, 1997). The interactions between the user, the airport, and the airlines and the resulting problems become clear in the model.

It gives a first impression of how complex the whole system is and shows the necessity for sound planning when designing an airport. As Frankfurt Airport exists already in its current state and the planning was carried out 40 years ago under completely different circumstances several other restraints could be added as well (e.g. security issues).

Their second model is represented in Figure 8. It clearly shows the process chain and necessary facilities for an airport – again, of course in a very simplified way.

Nevertheless also this model helps to gain an initial understanding of what this research project actually deals with.

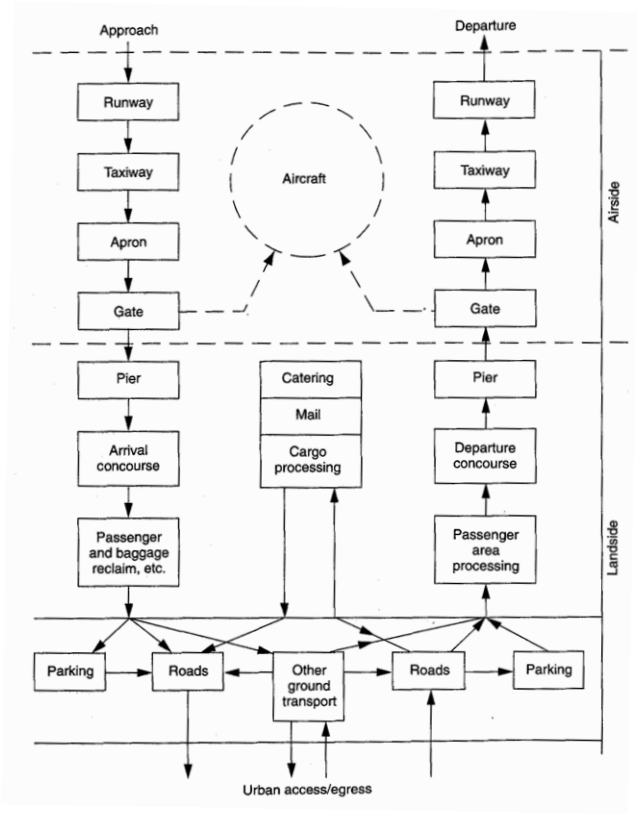


Figure 8: Model of an Airport (Ashford, Stanton, and Moore, 1997)

Besides the above described models Ashford, Stanton, and Moore have also analyzed the often controversially discussed issues around the hub problem (Ashford, Stanton, and Moore, 1997) – mainly the occurrence of peak waves floating into the airport and the need for appropriate re-scheduling or de-peaking strategies to minimize the negative side-effects of hub congestion (e.g. delays, queuing issues). As already mentioned at the beginning of these paragraphs their work on airport operations provides a deep and sound insight into the airport business.

The final two authors I would like to present here are ***Richard de Neufville*** and ***Amedeo Odoni***. The former is professor of engineering systems and of civil and environmental engineering at the Massachusetts Institute of Technology (MIT). He is considered a top expert in this field, looking back on long years of working for numerous airport authorities around the world, and has received the FAA Award for

Excellence in Aviation Education. The latter is the T. Wilson Professor of Aeronautics and Astronautics, and professor of civil and environmental engineering; as well as, co-director of the global airline industry center at the MIT. He is a specialist in operations research and other quantitative methods. Both professors rank among the top five in the field and have lasting influence in the business.

Their book “Airport Systems – planning, design, and management” (de Neufville and Odoni, 2003) ranks among the most important resources when it comes to airport planning, design, and management. The book itself deals with all sorts of aspects, beginning with an outlook to the future of the business, through system planning from airside to landside issues, closing with analysis methods. However, most important for this work are their chapters about air and landside delays. The reader will find a closer examination of these chapters in the following subchapter “Punctuality management”.

The conclusion that de Neufville and Odoni draw in their book, is that taking all current trends into consideration, the aviation business will undergo a substantial change in the coming years influencing all aspects in the field. Narrow technological perspectives will not be satisfactory anymore. Systemic approaches will be the future combining all sorts of performance factors with commercial ones. De Neufville and Odoni talk about a “democratization” of the airline and airport business. (de Neufville and Odoni, 2003)

Of course there is further literature available about aviation management. However, it is suggested that the above selection comprises the most important and influential authors and books in the field. The following subchapter will provide an overview over the relevant literature specifically concerned with punctuality issues at airports.

2.2.5. Punctuality Management

This subject has not received much attention from researchers. Therefore, the theoretical background is relatively thin. The topic punctuality performance has mostly been examined by consultancies or by the relevant airlines or airport authorities, but seldom from a scientific point of view.

As mentioned before, de Neufville and Odoni mark a notable exception in this case. Based on their engineering and operations research backgrounds they have scrutinized the issue thoroughly. They revealed numerous reasons for delays at airports. The central outcomes of their research are these three postulates about airport delays:

- they may be present even during periods when demand is lower than capacity
- they depend in a non-linear way on changes in demand and / or capacity becoming very sensitive the closer demand is to maximum capacity
- they exhibit a complex dynamic behaviour over any time span when the runway system is utilized heavily.

Moreover, de Neufville and Odoni claim that delay length and variation rises non-linear with increasing utilization of an airport system. In cases when the utilization rates exceed 85% to 90% of maximum capacity, delay length and variation will reach unacceptable levels. Interesting in this respect is the fact that Frankfurt Airport currently runs at an overall utilization rate close to maximum capacity and even exceeding that almost every day during certain main peak periods.

To come back to de Neufville and Odoni's (2003) work - during their studies they also found that the demand peak and the delay peaks do not necessarily occur at the same time. There are time spans of up to three hours in between. According to de Neufville and Odoni, this is mostly due to very complex flow and queuing processes. With the help of quite extensive mathematical equations originating from the field of

stochastic and queuing theory these effects can be modelled. The central outcome of their research in this field can be summarized as follows:

- Airport operators should not operate their facilities close to or above maximum capacity
- Doing so would risk having long delays, long waiting lines and a poor level of service.
- Delays during operation close to maximum capacity do not only increase drastically in their length and frequency but are also subject to unpredictable variability
- Under the same set of a priori conditions delays on one day may be modest while on another day will reach extreme levels
- Many initiatives at major airports aim at producing major changes while keeping costs low, however mostly only small changes, much less than expected by airport operators, can be observed. (de Neufville and Odoni, 2003)

Due to their background de Neufville and Odoni chose a rather mathematical approach. However, as this study is starting from a Human Factors perspective it might be closer to the second group of research work that is described next. There are quite a few studies on on-time performance at major airports mostly carried out by consultancies.

The most widely recognized punctuality study among them in Europe is the Booz Allen and Hamilton paper “How airlines can improve on-time performance” (Niehues, et. al., 2001). The Booz Allen and Hamilton team included all major European network carriers. During the research process it became obvious that the major problem regarding on-time performance analysis lies in the qualitative richness of data available from the organization that needs to be grasped by quantitative measurement tools.

However, three major adjustable factors in order to successfully influence punctuality were identified:

1. Network planning and control
2. Aircraft Availability
3. Ground Operations and Departure Process

In order to adjust them properly and therefore make the right trade-off decisions between cost, utilization, and punctuality the root causes of the problem needed to be scrutinized. The methodology of the abovementioned study followed a three dimensional approach which contains process monitoring and sampling, simulation, and rather more conventional methods such as delay code frequency analysis, correlation analysis, and fishbone diagrams.

The central outcomes of this study were these six points:

Punctuality…

1. is not only a quality issue – it reduces costs.
2. differentiates airlines from their competitors.
3. is a powerful performance indicator – when operations are punctual most other performance indicators are “green” as well.
4. is a tool for bridging inner-organizational boundaries
5. should be treated equally to costs and quality in contractual agreements.
6. is a leadership challenge that requires high priority in order to motivate the whole organization.

Impressive in this regard is the finding that four to sixteen million Euro could be saved annually by reducing the number of delays by just one percent in the fifteen minute threshold usually applied. This number applies to major carriers such as Lufthansa.

However, the study also found out that punctuality levels, close to or even above, 85% are hard to be reached and then mostly at unacceptable costs. Therefore, precisely calculated trade-off decisions between punctuality vs. turnover and yield or vs. cost and equipment utilization respectively must be made by management.

As this study is mainly concerned with the last of the three before mentioned levers, namely Ground Operations and Departure Processes – the approaches described by the study to improve the situation there is certainly of greatest importance.
The study of Booz, Allen and Hamilton consultants (Niehues, et. al., 2001) claims three major points need to be implemented in order to successfully influence the departure punctuality on the ground.

- **Process engineering** → Thorough operational diagnostics
  → Implementation of improvements
- **Empowerment, motivation, and discipline**
  → Highly motivated people, empowerment of front line staff supported by adequate incentive schemes can do more for punctual operations than millions of investment dollars
- **Supplier relationship and performance**
  → Integration of critical milestones in the departure process as performance indicators
  → "Extended Enterprise" approach to manage the entire process beyond organizational boundaries

As to the second lever "Aircraft Availability" Booz, Allen and Hamilton consultants (Niehues, et. al., 2001) also identified three points of potential improvements. These are: fleet structure and reserve planning, unscheduled maintenance, as well as spare part and workshop management.
Of central importance in this regard is the homogeneity of the fleet allowing a minimum of vulnerability following version or equipment changes.

The third lever elaborated on was “Network Planning and Control”. On this point, sound planning was identified as the most important basis for the punctuality performance of an airline. Furthermore, a well designed network structure and appropriate block, ground, and, most interestingly, slack time deployment show a tremendous significance. Moreover, the study recommended a “center of gravity” for the operational procedures – basically a central control unit. As a last point, effective strategies for recovering from major delays were mentioned. The consultants even recommended to value punctuality above regularity – consequently airlines should rather cancel individual flights in order to regain control over their schedules (Niehues, et. al., 2001).

2.2.6. Quality Management

While the previous chapter was concerned with literature directly dealing with on-time performance issues, this one will take a more indirect approach. The study of Booz, Allen and Hamilton (Niehues, et. al., 2001) claimed outbound punctuality is an indicator for the quality of the performance of an airline. Also, de Neufville and Odoni’s work considered the level of service as a clear quality issue. Therefore, it seems logical to consider quality literature for this study as well. There is ,of course, a tremendous amount of literature available on this topic – not specifically dealing with punctuality issues but with quality in general. However, as the chosen approach for this study is not coming from this field, it seemed unnecessary to include a full account of quality management literature. Instead, the author chose two representative works for the field.

The first is probably the most influential book on service marketing in the German language – namely Heribert Meffert and Manfred Bruhn’s book “Dienstleistungsmarketing: Grundlagen, Konzepte, Methoden” (“Service Marketing: Basics, Concepts, Methods”, the author) (Meffert and Bruhn, 2000). The book presents very detailed insights and conceptualizes quality management issues as part of service management. The topic is examined from various perspectives taking customer perceptions and the companies’ view into account. Various factors are shown and especially the relation between fault costs and preventive costs is

scrutinized. Moreover, the authors stress the importance of a well designed complaint management scheme. According to Meffert and Bruhn, quality management is basically divided into four major individual processes which take place at the same time or in sequence. These are quality planning (i.e. customer or staff surveys, etc.), quality steering (i.e. incentive schemes, training, etc.), quality auditing (i.e. customer satisfaction tracking, complaint analysis etc.) and finally quality management presentation (i.e. publishing of quality statistics, etc.).

The second piece of research to be mentioned in this respect is a somewhat historical document (Herbst, 1977). During the intensive literature study at the library of Dresden University of Technology, a document dating back to 1977 – more accurately a thesis from the former German Democratic Republic – captured the author's attention. Although written in a former communist country under a planned economy, Herbst had at that time already emphasised the importance of outbound punctuality as an indicator for overall service quality. Herbst claimed that an overall high level of service quality includes departure and arrival punctuality as central issues. As these issues are directly perceivable by the passenger he awarded them special importance. Furthermore, he argued that a high level of on-time performance could be used to differentiate a company from its competitors. Moreover, he claimed that the punctuality performance should be taken as the major indicator of whether an operation is soundly designed or not. As the study was written in a communist country, Herbst also referred to certain moral issues and stressed engagement of every staff member to help building a better world. Due to the very special economic and political environment his work refers to, it is difficult to transfer all the findings to our modern times, nevertheless it seemed interesting and worthy of mention.

2.2.7. Surveys in Organizations

The heading above is anticipating the result of the choice of the basic approach to this research project. The survey method was chosen after thorough consideration of all possible alternatives – however, due to its unique characteristics, the survey method seemed most promising for this purpose. Other alternatives such as field and laboratory experiments promised to either provide unsatisfying results or were

basically unsuitable for given problems under the given circumstances. This chapter does not aim at giving a broad overview about all possible approaches that could have been used, but rather provides a deep review about the chances and risks of the survey method. Moreover, the set of tools that a survey approach offers as well as its advantages and disadvantages, will be subject to closer examination.

Surveys have a long tradition in the organizational sciences. Therefore, one can fall back on a broad variety of literature available about the topic. In addition, a comprehensive preoccupation with the topic has led to a sound understanding of the method among researchers. This has also led to a common agreement about a set of certain advantages and disadvantages, risks and limitations of the approach. Exemplary, the author would like to mention the contribution of S.E. Seashore, program director emeritus of the Institute of Social Research at the University of Michigan to G. Salvendys “Handbook of Human Factors” (Salvendy, 1987). Coming from a Human Factors background, his summary about the positive and negative characteristics of the survey method seemed most promising. Nevertheless, the reader should be aware that this choice represents just one possibility among many others. However, as stated before, there is a common agreement in the literature which allows us to consider Seashore’s summary as representative.

According to Seashore, surveys can be utilized in manifold ways in an organization and for various purposes. These may be the intention to predict future developments; or the search for an explanation for a certain problem; or the need for monitoring change that an organization is currently undergoing; or the evaluation of certain processes started; or producing a basis for a certain decision to be made; and finally basic research in order to scrutinize not yet understood issues.
Following Seashore’s exposition, these are the main advantages of the method:

1. Surveys can be conducted with assured anonymity and / or confidentiality for the respondents, thus allowing the treatment of sensitive topics, opinions, and so forth usually not subject to open discourse.
2. With sufficiently large samples, statistical analysis can be applied and statistical results can be derived.

3. Standardized questions and formats allow an easy replication and / or extension to other groups and organizations
4. Cost effectiveness – especially questionnaire surveys provide an easy way to gather information about a broad variety of topics from a relatively large number of people at a relatively low cost basis.

However, there are also disadvantages. Seashore put the following risks and limitations of the method forward:

- Ambiguity of Purpose: management and other parts of the organization may not agree on the purpose of the study which therefore may have very limited practical utility for the planning
- Distrust: there must be an initial trust in the survey as a whole and the assurances concerning confidentiality and anonymity from the employees in order to take part
- Unacceptable topics: in each organization there are topics that are either too controversial or are not to be discussed for one or another reason
- Organizational disturbance: the conducting of a survey is linked to a certain time involvement for the respondents. Furthermore, the survey may raise unrealistic expectations of further action

These are just a few risks and limitations, however. Seashore also claims that bearing in mind these points during the planning process can at least limit their negative influence. The planning of a survey should therefore be carried out very carefully as it lays out the basis for the success or failure of the whole work. Manifold issues have to be taken into consideration, among them design issues such as the tools for the survey (i.e. interviews or questionnaires), the population and sample size, pre-testing issues, and instrument development. In addition, organizational issues such as confidentiality, participation, voluntarism, and external help play an important role. Finally, Seashore claims that issues concerning the analysis and interpretation of the results should be planned carefully in advance.

As it was of specific interest to this study, a brief discussion about the tools, their pre-testing, confidentiality issues, and interpretation of the results will follow. As to the question whether interviews or questionnaires were to be applied, the decision was certainly not easy. Both tools have specific characteristics, advantages and disadvantages. The advantages of the questionnaire lie in its feasibility, its potential confidentiality, and cost effectiveness which predestine them for larger populations and sample sizes. However, the interview allows the researcher deeper insights and the possibility to interact with the respondents. Nevertheless, it is more time consuming and therefore hard to realize in a time – sensitive environment. As to confidentiality – special requirements such as political, legal, or personal have to be taken into consideration. Management as well as labor union positions have to be carefully respected. Moreover, the respondents' trust in the researcher and the project need to be built up first. Finally, the interpretation of the results can easily be biased and should therefore be carefully evaluated and validated by the respondents. There are various levels of complexity conceivable approaching the interpretation, the choice of which level to use also influences the overall outcomes.

As one can see, a survey is complex to plan and carry out. One has to be very careful at every step. Nevertheless, it seemed to be the most appropriate choice for the problem under investigation in this study.

2.3. Conclusions

The previous chapters aimed at providing the reader with the necessary background information. In addition, the present chapter intended to create a general theoretical understanding of the problem under investigation.

The chapters showed that there is a tremendous amount of literature available on the topic of airline management. However, the specific issue under investigation in this study lacks attention by researchers. Nevertheless, the literature that does exist showed that the topic has various facets. Furthermore, the review showed the different perspectives the problem could be tackled from.

The underlying theoretical framework was introduced – namely an advanced Human Factors perspective following Vicentes theories. This extended view on Human Factors includes organizational as well as political issues which were of central interest to this study.

As a logical consequence to this initial choice, an appropriate methodological framework was introduced – namely an organizational survey method. The advantages of the study lie quite clearly in its relatively easy feasibility. However, the method also holds certain disadvantages which were to be taken into consideration.

3. Methodology and Procedure

3.1. Introduction

The method and procedures used during a research project need to be well chosen and designed in order to achieve the aim intended. The following sections will describe and explain how the data was gained and analysed. Moreover, issues such as reliability and validity of the outcomes of the research will be discussed. The chapter will finally present a graphical outline of the research process.

3.2. Research Approach: Quantitative and Qualitative

This section aims at discussing the general approach to the problem under investigation. Therefore, it will be of theoretical; one could even say philosophical, nature dealing with the underlying paradigm of the research. The approach chosen could be called a “semi”- critical one. Although the author is aware that a “semi”-critical approach does not really exist, the further discussion will clarify the underlying ideas.

Critical theory originates in the Frankfurt School, i.e. members of the Institute for Social Research of the University of Frankfurt in Germany. Contrary to “traditional” theory that is based on scientific knowledge as the only source of authentic knowledge, critical theory is oriented towards social change (Horkheimer, 1982). This also comprises involvement of the researcher contrary to the purely observational mode of “traditional” theory. Leading theorists in the field are Max Horkheimer, Juergen Habermas, and Erich Fromm. The underlying concepts for the theory come from Kant’s “critical philosophy” and Karl Marx. Critique in their sense is connected with philosophical reflection on the limits of claims made for certain kinds of knowledge the emphasis on moral autonomy (Horkheimer, 1993).

Linking this back to the specific topic under investigation in this work raises the question: which approach to choose? The crucial question behind all that is – at least in the author's opinion – how can the perception of staff about the quality of a process design be measured best?

Since the author considers things like perception and quality assessment as being very subjective matters, one would have to tend to an interpretive approach, giving the researcher the opportunity to interpret the respondents' answers. Interpretive approaches – not being based on quantitative backgrounds – are commonly attributed to have a critical tendency.

On the other hand, one needs to derive answers for the management to assist them in their decision making – something one could call "hard facts". Therefore, quantitative means also have to be considered as they provide results that are more able to be generalized than the outcomes of purely qualitative means. However, that would interfere with the argumentation above, that is, it shows a tendency towards a positivist approach, clearly attributed to "traditional" theory.

Bringing together the better of the two worlds, positivism on the one hand and interpretivism on the other hand, seems to be the only way out. This leads the author to choose an intermediate approach with a basically critical tendency as it enables the researcher to combine the methodologies of both approaches while allowing him to get involved with the topic and to include his or her interpretations. This does not mean that the researcher is undecided. It just gives one the chance to critically assess the quantitative outcomes as well as the qualitative results.

However, the chosen approach was called a "semi"- critical one. This is mainly due to the fact that the author would like to leave out the moral level and orientation towards too radical social change of the critical approach as stressed by Horkheimer (1993). For Horkheimer:

"... a theory is critical to the extent that it seeks human emancipation, to liberate human beings from the circumstances that enslave them" (Horkheimer 1982, 244).

The author is aware that this undermines the fundamentals of the critical approach. However, this clearly defines the intermediate position of the chosen approach.

It is that kind of moral involvement that brings science and scientific research nearer to where it started from – beliefs and speculation. The philosophical discussion about this issue would go too far here; therefore, the reader is asked to accept the above as a position statement.

In conclusion, one can say that a basically critical approach to the given problem would probably fit best as it enables us to use quantitative as well as qualitative methodologies and to include interpretation of the results from the subjective perspective of the author. This is considered as to be of particular importance as issues like perception and quality assessment are to be approached from a subjective point of view in this research project while there is also a certain need for "hard" facts to assist the management in its decision making processes.

In contrast to this rather philosophical chapter the following sections are concerned with concrete methodologies applied in the research process.

3.3. Data Collection Procedures

3.3.1. The Delay Codes

In order to collect statistical data as reference to the answers of the respondents of the survey, delay code statistics were used. As they were easily accessible through Lufthansa computer networks and are basic to the official punctuality statistics of the airline, they seemed appropriate for the purpose of this study.

These numeric codes represent underlying reasons for departure delays. They follow IATA standard regulations (see Appendix II for a complete list). Moreover, Lufthansa uses an additional letter code in order to specify the delay reasons closer (see Appendix II for a complete list). Delay codes are assigned to every departure delay event lasting longer than three minutes. However, according to IATA standards

(IATA, 2005), delays up to fifteen minutes are ignored and the flight event is counted as punctual. Only delays above this 15 minute threshold affect the punctuality statistics.

The delay codes are allocated following a standard procedure: the flight managers at the gate and the head loaders at the aircraft report the reasons (not the delay codes!) for the delayed departure to an event controller in the Hub Control Center. From this information and under inclusion of all other information, the controller allocates the appropriate delay code. This code is then published in the various computer systems from were they are available thereafter. This procedure seems to be quite simple and clear. However, the reader should bear in mind that all players are under high pressure and workload, and especially the controller is usually supervising numerous flights at a time. The shortcomings of this process will be subject to the later discussion.

In order to support the controller, Lufthansa runs a complex network of sensors and switches at the airport that reports exact time stamps of important key milestones in the handling process.

This comprises issues such as closing and opening of cargo and passenger doors, completion of fueling, cleaning and catering, time of pushback, and many more. All this data is transferred through various systems (i.e. ACARS) to central computer software called “Allegro” which makes this data available to everybody with the necessary authorization.

All data together is consolidated by two major computer programs from where the data for this study was derived – namely “Obelisk” and “DASGO”. In a next step this data was clustered according to further IATA standards (IATA, 2005) until it could be presented in the form as available in chapter four. Hereby, certain groups of delay codes are clustered and labeled (i.e. Technical, ATC, Airport, etc.).

A detailed analysis of the delay codes can be found in chapter four. The before mentioned shortcomings of the process of delay code allocation will be subject to the discussion in chapter five.

3.3.2. The Survey

The survey among the Flight managers, Assistant Flight Managers, and section leaders is the central part of this work. As mentioned before, their attitude, beliefs and perception towards punctuality was the subject of interest. Linking this back to the before mentioned Human Tech Ladder, the survey approaches the topic on the team and organizational level thus trying to evaluate communication patterns and identifying underlying “culture” aspects.

Looking at the following definition of a safety culture indicated parallels to the issue under investigation. Generally, the word “safety” cannot just be exchanged by “punctuality”. However, in several places it can:

Safety Culture:

- Those aspects of culture which affect safety
- The characteristic shared attitudes, values, beliefs and practices concerning the importance of health and safety and the necessity for effective controls
- The safety culture of an organization is the product of individual and group values, attitudes, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization’s health and safety programs. Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy of preventive measures (Booth, 1996)

The underlying idea of the survey therefore was to assess whether something like a “punctuality culture” exists at the Lufthansa station and how strong it is. Moreover,

the idea was to illuminate possible improvements of the on-time performance by improving the inner-organizational punctuality culture.

Starting from this point of departure, it seemed logical to adapt methodologies used in previous research to identify the state of a cultural issue. As the above definition was coming from a Human Factors field – namely safety management – it furthermore seemed appropriate to adapt an already existing methodology from that field.

The method finally chosen was the safety culture assessment tool developed by AEA Technology during the early 1990s. This tool was an attempt to identify the weaknesses and shortcoming of the safety culture of an organization operating in a high tech environment. The factors shown in table 1 were identified as central issues. (van Steen, 1996).

Table 1: Factors AEA Safety Assessment Tool (van Steen, 1996)

Management and Organizational Factors	**Enabling Activities**	**Individual Factors**
- Positive organizational attributes	- Reinforcement and incentives	- Individual responsibilities
- Management commitment to safety	- Communication	- Individual perceptions
- Strategic flexibility		- Training
- Participation and empowerment		

Following this guideline the researcher derived a questionnaire for the purpose of this study that covers the above mentioned issues. The reader will most certainly be able to find the parallels in the questionnaire used for this research (see Appendix I for complete questionnaire). Table 2 shows which items in the questionnaire could be assigned to which factor in the AEA safety assessment tool. Of course, not all questions fit this scheme. As the objective of the research changed from safety to punctuality, some adaptation was necessary. Moreover, the analysis of the

questionnaire follows a different approach. Nevertheless, the underlying structure of the safety assessment tool becomes evident.

Table 2: Underlying structure of the questionnaire

Management and Organization Factors	Questions	Enabling Activities	Questions	Individual Factors	Questions
Positive organizational attributes		Reinforcement and incentives	D04,D05	Individual responsibilities	D07,E01,E02
Management commitment to safety	E03,E04	Communication	B01,B02,B03 B04,B06,D03 E05	Individual perceptions	C01,C02,C03 C04,C05,D06 D08,E06,E07
Strategic flexibility				Training	B05
Participation and empowerment	D01,D02				

This questionnaire was sent to the Flight Managers and Assistant Flight Mangers via e-mail and was handed out in printed form to the Section leaders. Participants were asked to return their filled forms to boxes that were placed close to their break lounges. They were then collected by the author and analysed. The survey was carried out during July 2005.

Table 3 shows the figures for the population, the number of participants, and the response rates. The Figures are accurate estimates taking into consideration that some of the members of the population were on holiday, absent due to illness, or delegated. Moreover, the total number was reduced by pregnant women and those currently under legal protection for expectant mothers.

Table 3: Figures of Participants

Population	18 Section Leaders
	150 Flight Managers & Assistant Flight Managers
Total:	168 Persons
Participants	18 Section Leaders
	115 Flight Managers & Assistant Flight Managers
Total:	133 Persons
Respondents	6 Section Leaders
	28 Flight Managers & 10 Assistant Flight Managers
Total:	44 Persons
Response	33.3 % Section Leaders
Rate	33.0 % Flight Managers & Assistant Flight Managers
Overall:	33.0 %
Gender	89 female persons of the participants
	44 male persons of the participants

As the reader can see from the questionnaire the participants had either to answer multiple choice questions or open questions. The scale reached from 1 to 5 where 1 represented “Yes” or “Full Agreement, and 5 represented “No” or “Total Disagreement”. The participants were furthermore provided with an explanation of how to use the scales and how to fill in the forms. A small test prior to the survey showed that there were no major problems in connection with filling out the forms.

There were 36 items in the questionnaire which were divided into 6 clusters, each dealing with a separate field. These clusters were:

1. General Questions
2. Information / Communication
3. Central Hub Control
4. Ideas and Motivation
5. Punctuality Management
6. Delay Reasons

In addition there was a last item allowing the respondents to generally comment on the issue of punctuality at Frankfurt Airport.

While the delay code statistics provided solely numerical data, the survey also generated a tremendous amount of qualitative data. Moreover, the researcher gained deep insights and detailed knowledge about the processes, their shortcomings and the overall situation at the airport. All this information was subjected to a detailed analysis. Chapter 3.4. includes an overview about how the analysis was carried out and which methods were applied. The analysis itself is presented in chapter 4.

3.4. Data Analysis Procedures

As mentioned before, a broad variety of information was to be analysed during this study. The major focus was on the results of the questionnaire survey.

In a first step, all questionnaires were screened in order to gain a first overview over the data gathered.

In a second step, a codebook was developed. This tool helped to code the answers of the respondents in order to prepare them for further analysis. For the complete codebook please refer to the appendix section (Appendix III). Central issues in this phase of the analysis process were how to deal with answers that were not stringent, missing or not plausible.

In a next step all German data (i.e. the answers to the open questions) was translated into English. In order to avoid translation biases the well-known back and forth translation method was used. This method works as follows: the author translated the responses to the questionnaires from German into English. This translated version was then re-translated into German by a native speaker from the U.S. who is literate in German. Both, the original German version and the re-translated German version were compared. In case of discrepancies the differences in the translations were eliminated in a discussion process between the author and the native speaker.

Following this step, the data was entered into lists and each case was given an identification number. This work was carried out by the researcher and an auxiliary scientist in order to avoid mistakes and biases while entering the data – breaks every ten minutes were held. Moreover, the position of the data reader and the person at the computer was changed in every break. At the end of this process the researcher and the auxiliary scientist individually checked the data entered. No discrepancies were found.

The data was then processed by means of a MANCOVA (Multivariate Analysis of Covariance) in order to elaborate potential impacts that certain factors (e.g. gender, position, etc.) might have had. The results of the analysis of the answers to the questionnaires were then presented graphically in order to provide the basis for the further discussion. The MANCOVA was computed with SPSS software taking gender and position as factors and duration of service at Lufthansa as covariate into account. Although duration of service at Lufthansa does not entirely meet the criteria (e.g. interval scale) for being used as a covariate in a MANCOVA as the possible answers to the item were clustered beforehand, it still provided useful insights as a rough indicator whether the time of working for Lufthansa had any impact on the overall results.

Parallel to this analysis a second one was carried out in order to examine the delay codes. The data for this step was derived from the various Lufthansa computer systems. The delay statistics were computed for the complete year 2004 (as reference) and for 2005 until the 35th week. The large amount of data was then clustered according to the internationally common standards set by the International Air Transport Association (IATA). Later the statistical data was presented graphically as well.

The results of both analyses were finally combined in the discussion. The various outcomes were set into relationship with each other. From this discussion, final conclusions and implications were drawn. Following this step, feedback is planned to be given to the participants. Moreover, the study will be presented to the management team of the Lufthansa station.

3.5. Reliability and Validity

These two concepts bear substantial risks and opportunities for researchers. Due to the fact that they provide information to which extend the results of a study are trustworthy and reliable they are of considerable importance to any study carried out. Since no paper will ever have absolute validity and reliability, research should at least aim at reaching a sufficient level. In order to meet these requirements Yin's 4-step testing model (Yin, 1994) was applied.

The first step of this model tests the **Construct Validity**. It requires that data should be collected and analyzed from various sources in order to gather a wide range of information. According to Yin (1994) this minimizes the effects of information coming from a faulty source on the overall result of the study. Information from various sources can be cross-checked and is therefore considered to be more valid. The underlying construct of this study can be considered as to fulfil Yin's criteria. The reason is that the information from the participants can be cross-checked with experiences made by the researcher himself as he was at the airport during the entire study. Furthermore, all Lufthansa delay statistics were compared to external sources to avoid biases from that side.

The second step of Yin's test is on **Internal Validity**. This step deals with the correctness and trustworthiness of the collected data. It implies that Internal Validity is reached when the applied research instruments measure what they are supposed to measure. This was aimed for by applying well tested and widely-accepted methods. However, as these methods were adapted in order to meet the requirements of the problem under investigation, this point seems critical as well. Therefore, the questionnaire was pre-tested on a random sample of respondents. These respondents came from the Lufthansa station as well, however they were not part of the later set of respondents used for the survey. The outcomes of these tests were taken into consideration when setting up the final version of the questionnaire. Moreover, the reader should be aware that the whole research process took place in a German speaking country – the questionnaires were originally given out in

German. Later they were translated into English. Although measures were taken to eliminate translation biases, this risk cannot be ruled out completely.

The third step examines the **External Validity**. This step analyses to which extent the findings of a study can be generalized. As the study does not intend to generate generalized results, this point seemed of secondary importance. The work clearly aimed at providing useful information to the management of the Lufthansa station at Frankfurt Airport. As each airport is a unique and complex system it is certainly not easy to transfer findings from one to the other. However, certain findings can be transferred. This is the case when the findings do not implicitly touch operational issues. In particular, this comprises the findings concerning staff motivation, intra-organizational communication patterns, and management commitment to punctuality.

The very last step of Yin's test deals with **Reliability**. He claims that this aim is reached if a study leads to basically the same results when carried out again under exactly the same conditions. On condition that a future researcher is provided with the same sources and is following the applied method he will at least come to comparable findings. As the answers to questionnaires are also partly influenced by external factors not within the sphere of influence of the researcher, this part of the study could eventually lead to slightly different results, although the major direction should still be able to be reproduced. However, the statistical data from the computer systems will certainly be equally accessible to any researcher. Therefore, I consider this point as covered. (Yin, 1994)

Concluding, one can say that overall the study fulfils the major criteria of validity and reliability. Where these are not fulfilled to the extent intended by Yin, mostly specific characteristics of the given research problem are underlying.

3.6. Outline of the Research Process

Figure 9 graphically describes the major steps in the research process thus showing the underlying structure of the project. Of course it is not encompassing all details; it is rather to be seen as a model supporting the overall understanding of the research.

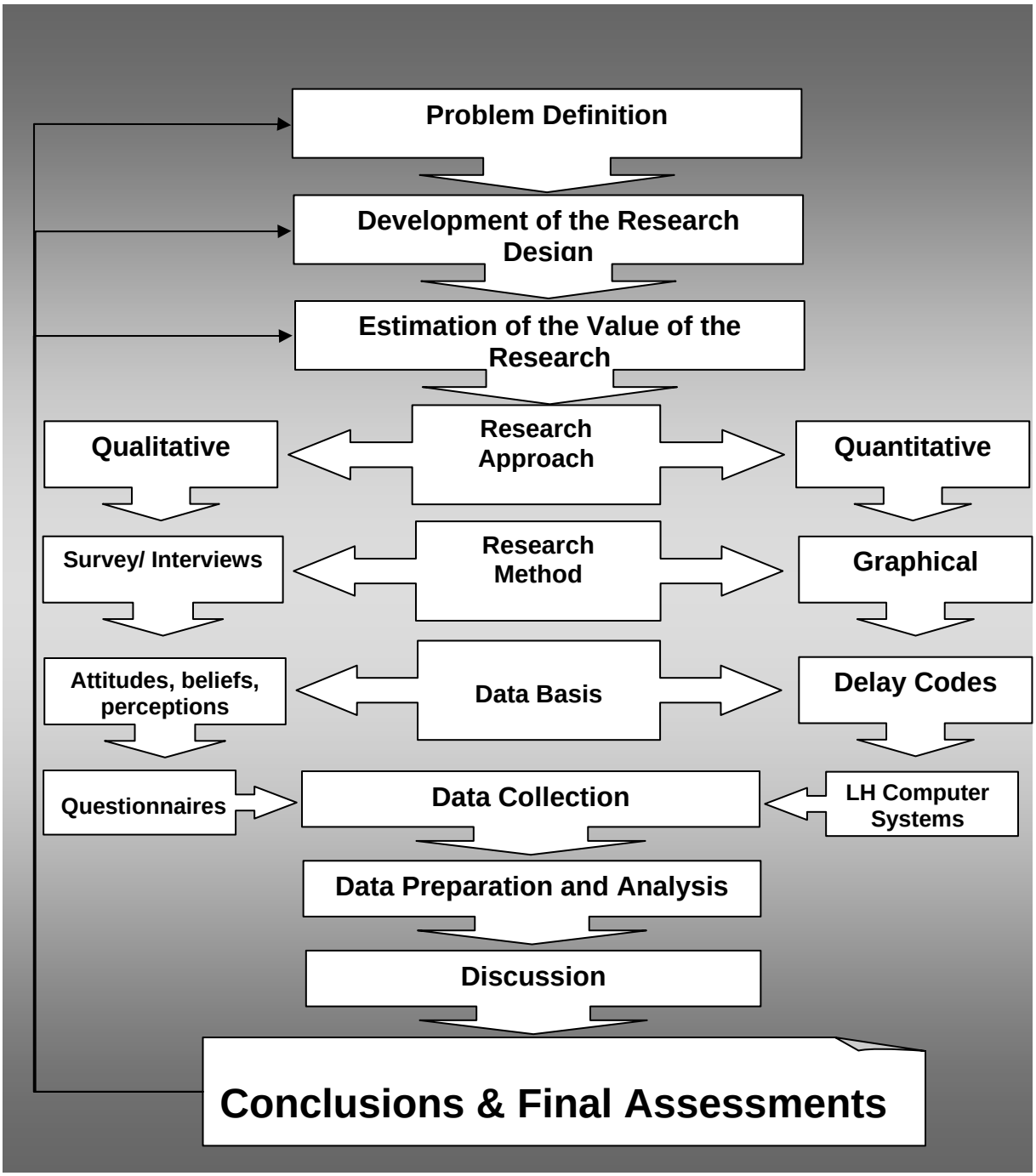


Figure 9: Outline Research Process

4. Data Analysis

4.1. Graphical Analysis of the Delay Statistics

The analysis of the data generated during the study will start with a detailed account of the punctuality situation at Frankfurt Airport on the basis of the delay code statistics published by the Lufthansa station. The statistics include all Lufthansa operated flights including Lufthansa Cityline.

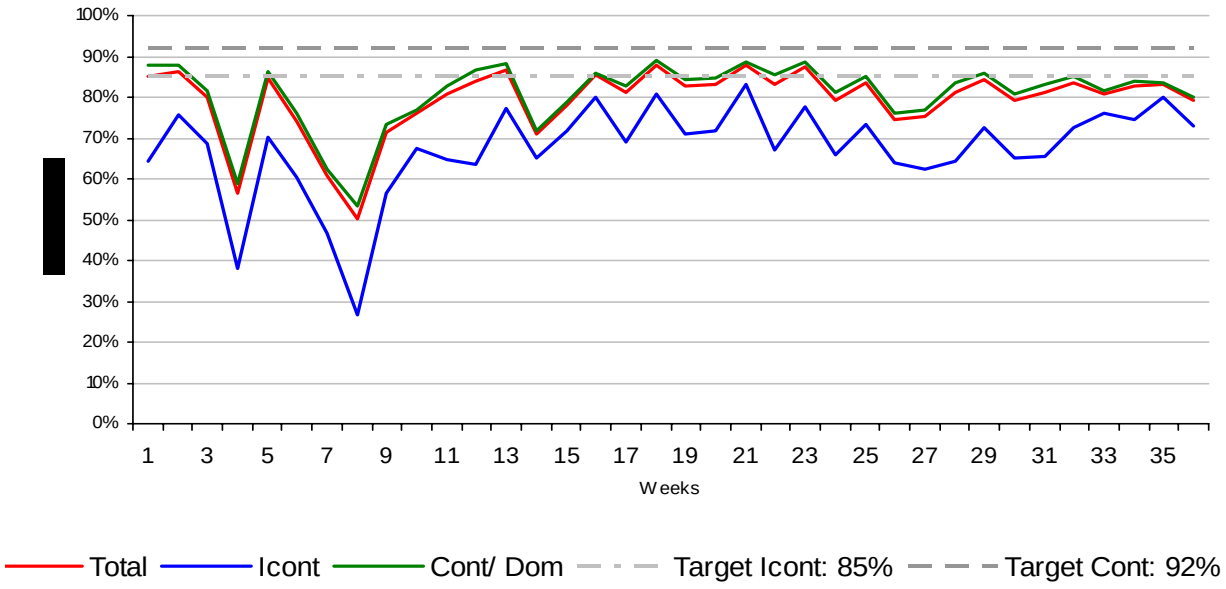


Figure 10: Punctuality statistics 2005 LH Station Frankfurt

As can be seen from Figure 10 above, the departure punctuality rate at the Lufthansa station is subject to major fluctuation throughout the year 2005. However, in comparison to previous years, this course shows similarities indicating that the major developments of the punctuality rate may be due to underlying seasonal characteristics. Moreover, the chart shows that the target rate for intercontinental flights is never actually reached at all. The same applies to the target rate for the continental and domestic flights.

Nevertheless Frankfurt Airport ranked second just after Munich airport among the European hubs in the punctuality statistics published yearly by the Association of European Airlines (AEA, 2005). However, one should bear in mind that the traffic volume at Munich airport is about half that of Frankfurt. More important the utilization

rate of the infrastructure in Munich is significantly lower than in Frankfurt (Lufthansa, 2005). Although Figures for 2005 indicate a similar position for Frankfurt Airport in the statistics, the above shown punctuality rate is understandably dissatisfying for Lufthansa. Being the most punctual hub in continental Europe at this level does not meet the standards usually applied to Lufthansa.

Figure 11 shows the development of the number of local guests (guests starting their journey at Frankfurt excluding transfer guests) handled by the Lufthansa station and the number of departing flights handled by Lufthansa. The Figure shows the growth at the Lufthansa station. The figures have to be considered taking into consideration that the number of staff has not increased accordingly. The number of guests handled per staff member jumped from 8313 in 2001 to 9275 in 2004 and will certainly be topped in 2005 if the current development continues until the end of 2005. Going along with this development is a rise in productivity (guests handled per employee) at the station.

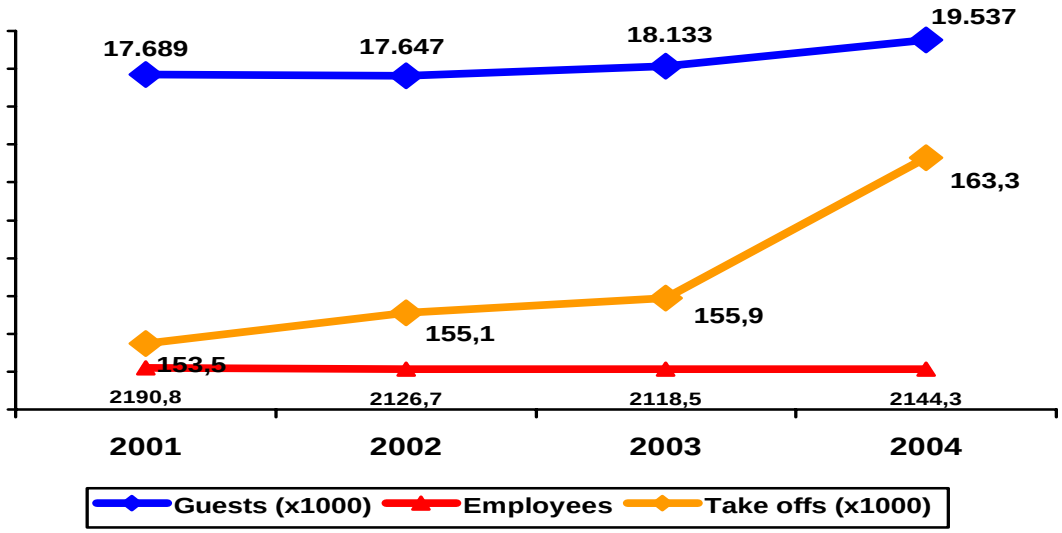


Figure 11: Boarded Guests vs. Take offs (Lufthansa, 2005)

Figures 12 and 13 show the analysis of the delay reasons as indicated by the delay code statistics. The clusters follow the international standard nomenclature of the International Air Transportation Association (IATA). A comparison between 2004 and

2005 (until week 36) indicates that the distribution has not changed significantly except the point “Technical” where a noticeable increase of 2% points was recorded.

Interesting in this regard is the fact that although passenger volume and traffic is increasing significantly, the portion of the handling delays was kept constant. In the smaller pie charts to the right, the delays were assigned following the causation principle. The only major change is the increase in delays coming from the handling process which indicates a certain problem concerning the “number of staff per passenger handled” ratio.

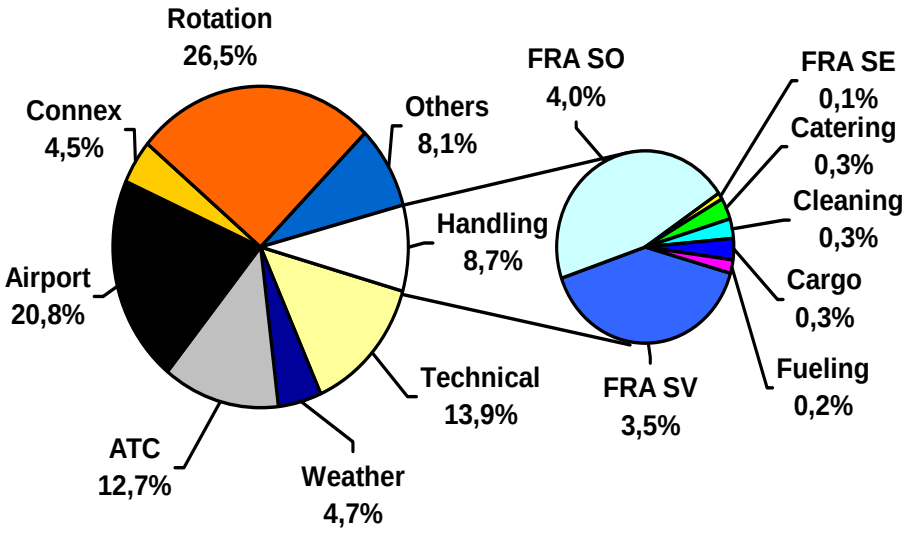


Figure 12: Delay Reasons 2005 (cumulative August 2005)

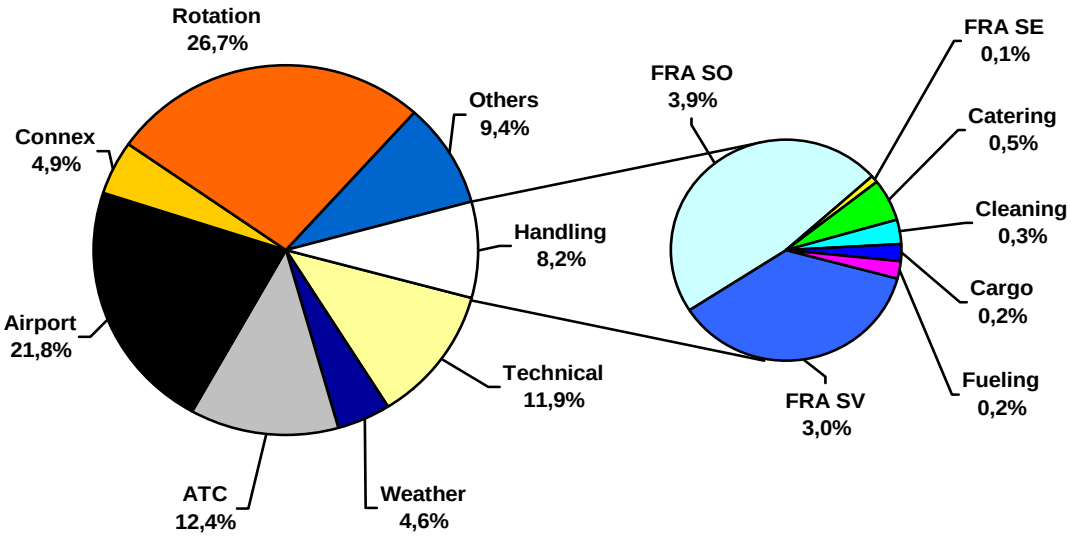


Figure 13: Delay Reasons 2004

Furthermore, one should also be aware that the clusters “Airport” and “Connex” are also closely related with the ground handling processes.

In the next five Figures a detailed course of the development of the separate delay clusters throughout the year is shown. The yellow area in the back shows the course of 2004 whereas the blue line indicates this year’s course. All values are based on accumulated delay minutes per hundred legs departed, computed for each week of the year. Moreover, the grey bars indicate the deviation between the two years – a bar in the negative direction of the scale indicates an improvement – meaning the occurrence of fewer delay minutes compared to the previous year. A bar in the positive direction indicates deterioration.

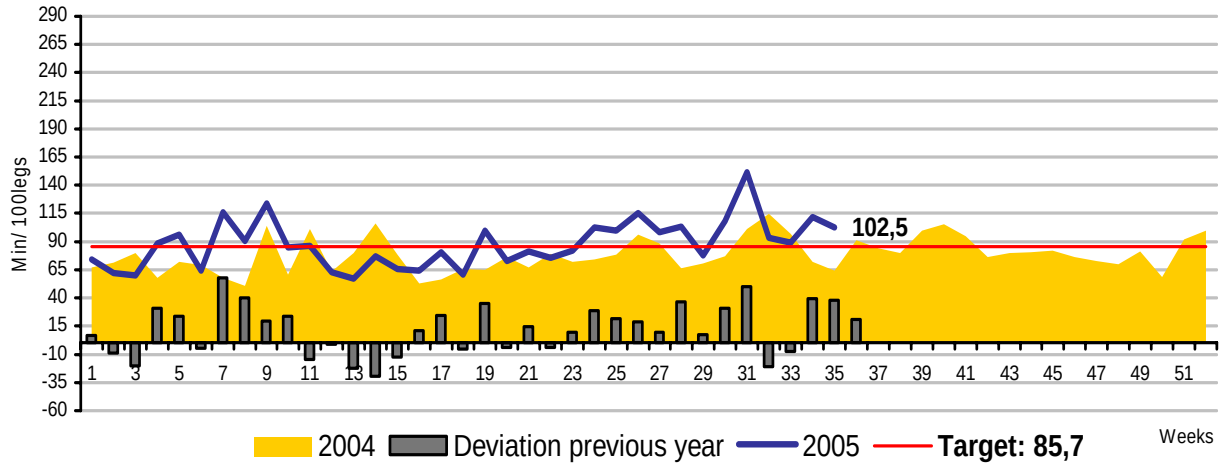


Figure 14: Delays Handling (Codes 11-39)

As this study is mainly concerned with handling processes, the analysis starts with the handling delays which can directly be assigned to the field of responsibilities of the Lufthansa station. As can be seen from Figure 14 above, the level of handling delays in 2005 is slightly above the level of 2004 and is exceeding the target value relatively often. Certain peaks in the course may be explainable by isolated cases such as the visit of the President of the United States to Germany, or emergency landings – this development clearly shows that there is space for improvements. However, in relation to the following clusters (compare also the two previous Figures) the handling process is not solely responsible for the current delay situation.

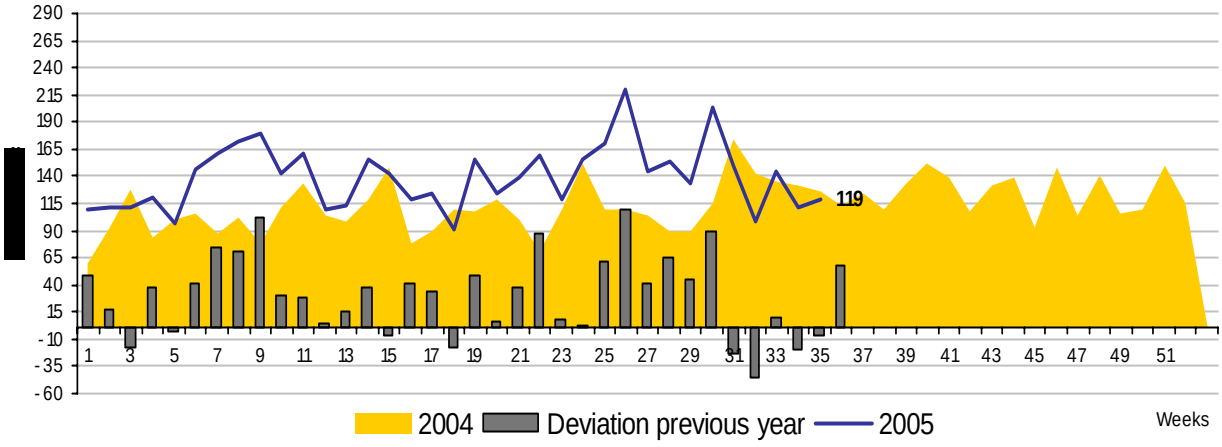


Figure 15: Technical Delay (41-49)

As mentioned before, the technical reliability of the Lufthansa operations is most definitely aggravating. As Figure 15 illustrates, the amount of delays due to technical reasons has increased significantly by about 20%. There are various reasons (e.g. ageing fleet, minimized ground times, higher utilization of the aircraft etc.) for these developments. However, as this was not the central issue of this study there will be no detailed account included at this place. Nevertheless, in order to improve the overall punctuality performance at the hub Frankfurt, Lufthansa most definitely will have to deal with this issue.

The next cluster under closer examination is delays that are due to Air Traffic Control (ATC) restrictions. This could be ATC at the airport of departure, the airport of destination, or en route restrictions as they often appear in peak times. As can be seen from Figure 16, there are dramatic faults in the course of the ATC delays. As they are very sensitive to traffic volume, weather influences, and exceptional events, they are certainly most difficult to deal with. Moreover, ATC does have an important influence on flight safety. Therefore, there is relatively small space for action. Moreover, “political” reasons have effects here. Nevertheless, there is certainly a – so far unused – potential for improvement in this field also.

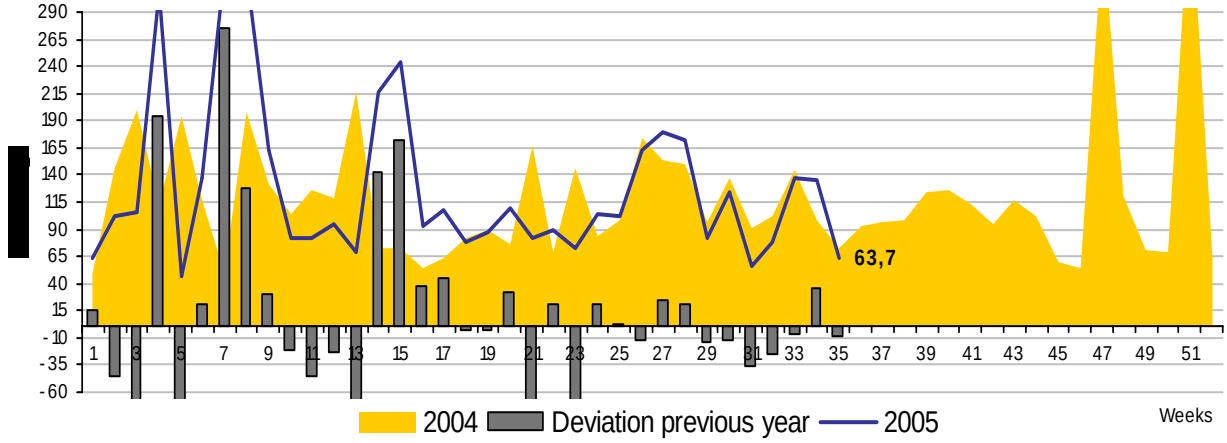


Figure 16: ATC Delays (Codes 2, 81-84, 89)

Before coming to perhaps the most critical clusters, some comments are required on connex delays. These delays play an important, if smaller, role. As can be seen from the Figure 17, this delay cluster is relatively constant. Although the values for 2005

are mostly at or above the levels of 2004, the amount of minutes caused by this factor is relatively small. Moreover, the allocation of Connex delays helps to improve the overall connectivity at the hub and has therefore a direct influence on customer satisfaction, respectively customer convenience.

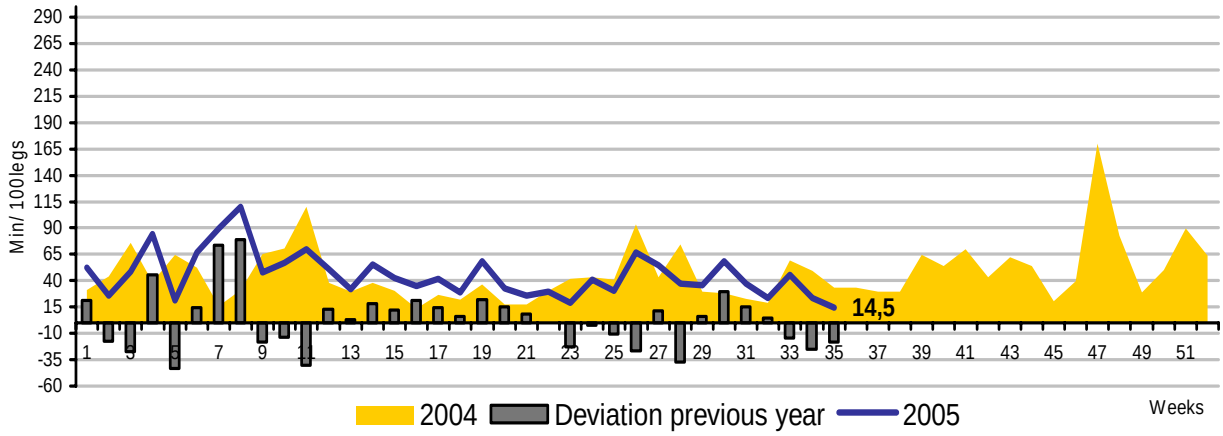


Figure 17: Connex Delays (Codes 91-93)

The cluster airport delay is the second largest delay problem besides the rotational delays. While rotational delays are usually caused at the departure airport or enroute to Frankfurt or are a consequence of departure delays on a previous leg ex Frankfurt etc. – airport delays are a major problem caused directly at Frankfurt Airport. As can be seen from the Lufthansa delay code list in the appendix (Appendix II) the codes 85 to 88 are mainly concerned with security, health, and infrastructural issues. Among the codes, number 85 “Mandatory Security” and 87 “Airport Facilities” play the most important role. Delay code 85 is the most applied code at the airport overall. As can be seen from the list this code encloses a broad variety of issues from congested security checkpoints (subcodes A and R) to unloading of luggage due to missing passengers (subcode B).

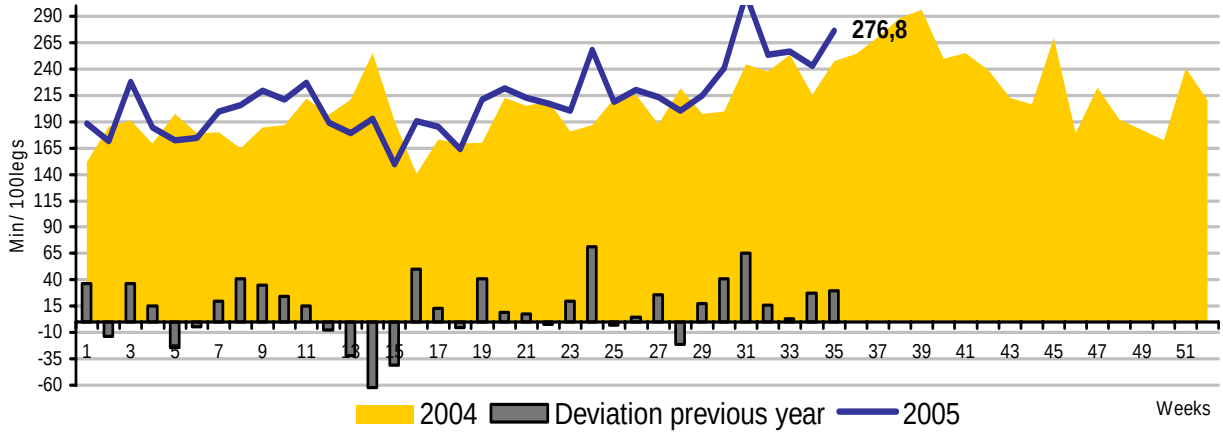


Figure 18: Airport Delays (Codes 85 - 88)

Especially the latter reason causes a major amount of delays each day. However, as Figure 18 illustrates, the course of the delay code has constantly been rising since the beginning of the year; at almost all times it is also above the level of 2004. There are various reasons for this development – one is certainly the increased amount of passengers handled in 2005 which of course has an effect on the likelihood of the occurrence of a situation where a passenger is missing at departure time.

In conclusion, one can say that punctuality at Frankfurt Airport as indicated by the delay codes is not satisfactory. In comparison to 2004 no major improvements can be seen. Taking the rising passenger volume into consideration besides other negatively influencing factors (e.g. new security measures etc.), the statistics at least seem to indicate a constant level of delays. An exemption is certainly marked by the rise of the delays due to technical reasons by about 20%. This is one of the major issues shown by the statistics. Nevertheless, the airport delays are the most critical factor at the airport. They account for about one fifth of all delays. The reader may wonder why rotational delays are left out here. As they mark a rather indirect issue caused by other reasons, they are hard to address directly. Also, if all other delays were minimized, the rotational delays would drop automatically as a logical consequence due to the network character of the Lufthansa operation.

4.2. Analysis of the Questionnaires

While the last chapter dealt with the analysis of the delay code statistics, this one is concerned with the analysis of the outcomes of the survey that was conducted among the Flight Managers, Assistant Flight Managers, and Section leaders at the Lufthansa station at Frankfurt Airport.

In order to structure the analysis and make it easier for the reader to follow, the chapter is set up according to the design of the questionnaire. Although the questions are shown in the individual sections as well, it is therefore recommended to have the questionnaire available during the reading of this section.

Furthermore, the questions are not represented textually in the figures; instead they are indicated by their item code which can be found in the first column of the questionnaire and on the y-axis or x-axis of the Figures in this chapter.

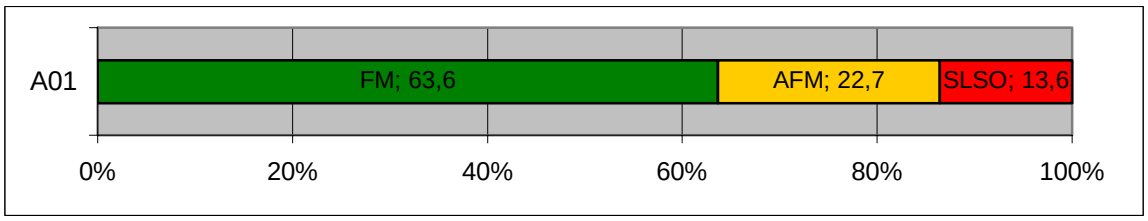
As to the response values, the Figures either represent percentages, time spans, or answer clusters depending on the scale of values used for the particular question in the questionnaire. Moreover, the percentages are always based on the total number of responses given to a particular question.

If clusters were built up, the rule for the clustering is presented below the specific item. As a scale reaching from one to five was used for the questions, where one represented full agreement and five total disagreements, usually answers one and two, and four and five where clustered together. Moreover, these clusters can be distinguished by their colour.

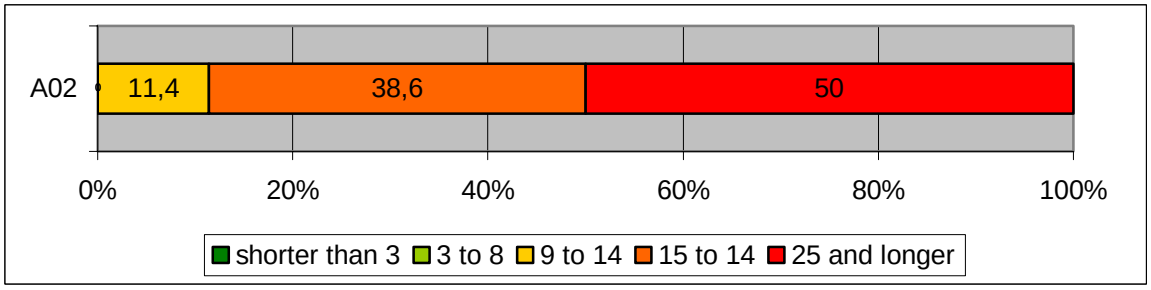
In order to further scrutinize the data; a Multivariate Analysis of Covariance (MANCOVA) was carried out. The findings of this analysis can be found in the individual section they belong to.

General Questions

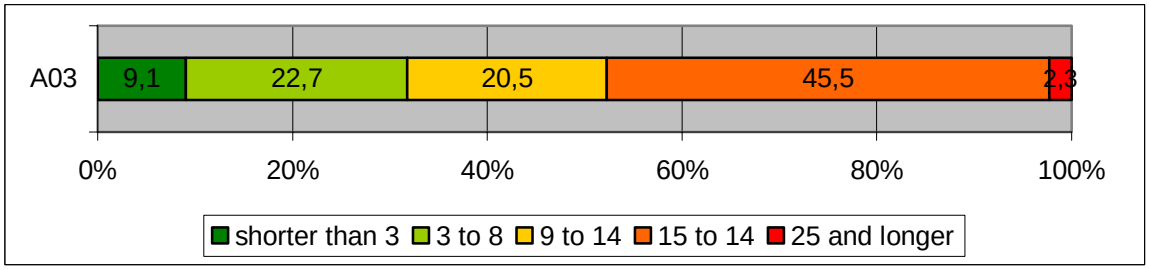
1. Position



2. Duration of service at Lufthansa



3. Duration of service in the specific position



4. Gender

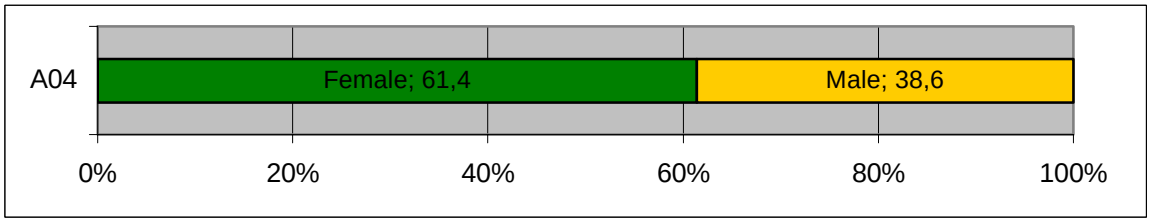


Figure 19: General Questions

The structure of the original sample and the one of the actual respondents is relatively equal (see Figure 19). The 115 Flight Managers and Assistant Flight Managers represent about 86% of the total number of participants. They are also represented by about 86% in the set of actual respondents. The same applies to the

Section leaders. One can therefore assume that the various groups of the participants are well presented in the set of respondents.

Moreover, one can see from Figure 19 that a majority of the employees in the relevant positions has been working for more than 15 years for Lufthansa. Not surprising is the fact, that the respondents have been working rather long in their position. This is mainly due to the nature of their positions which mark higher or even final positions in the respective career paths. On the one hand this seems to indicate that mostly experienced staff were among the respondents and on the other hand this shows that although they have been in their position for quite a while, they are still motivated to think about the jobs they are performing. The ratio of about two third female to one third male respondents is also reflecting the distribution in the original sample quite well.

Information/ Communication

This set of questions (Table 4) dealt with issues around whether and how the employees felt well informed and trained concerning punctuality issues. In addition this set aimed at examining whether there is an open discussion in a horizontal as well as a vertical way in the organization.

Table 4: Questions B

Item Code	Question
B01.	**Are you notified about the current status and the changes of the outbound punctuality quality on a regular basis?**
B02.	**Do you discuss punctuality issues with your colleagues regularly?**
B03.	**Do you discuss punctuality issues with your superiors regularly?**
B04.	**Are you notified about newly introduced punctuality measures regularly?**
B05.	**Are employees trained for outbound punctuality on a regular basis?**
B06.	**Do you get feedback about punctuality relevant incidents?**

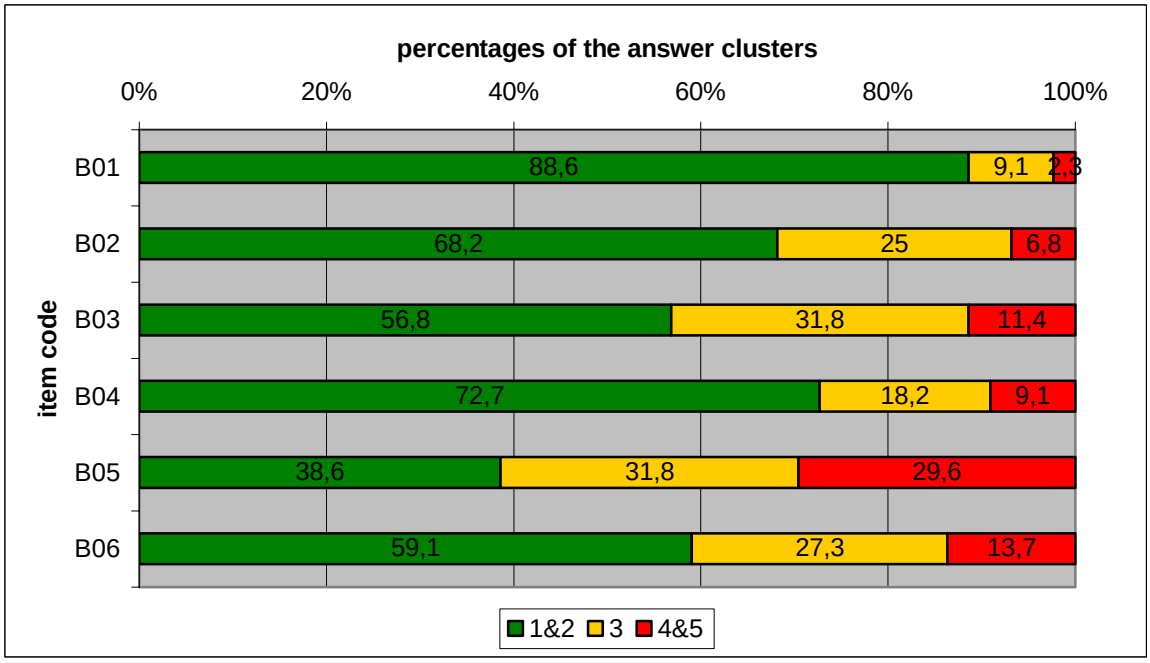


Figure 20: Information/ Communication

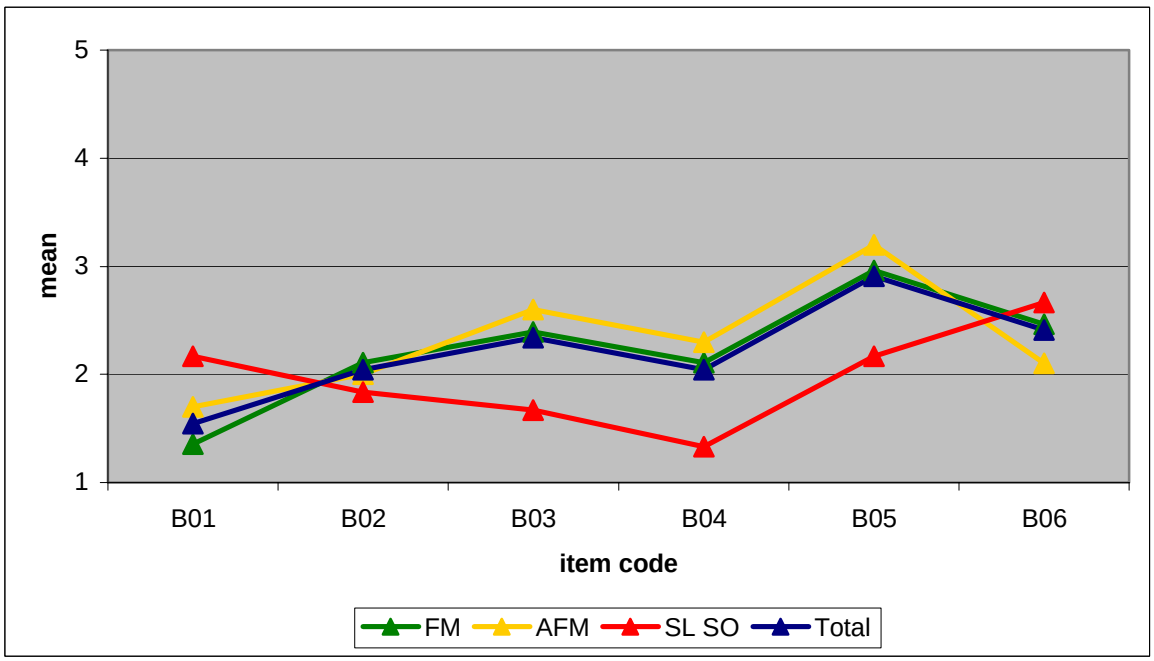


Figure 21: Means Information/ Communication

As Figure 20 shows the respondents have answered all questions quite positively. An exception marks questions B05 which asked whether the employees are trained regularly for outbound punctuality. The analysis indicates potential for improvements here. Another noticeable issue is the fact that the Section leaders seem to feel a lack

of feedback concerning punctuality issues which is reflected by their comparatively negative response in questions B01 and B06. However, the means in Figure 21 indicate that the Section leaders do have a different perception especially concerning questions B03 to B05.

Table 5: Multivariate Tests B Section

Effect		Value	F	Hypothesis df	Error df	Sig.
Duration of Service LH (A02)	Pillai's Trace	0,177	1,148	6,000	32,000	0,358
Position (A01)	Pillai's Trace	0,477	1,721	12,000	66,000	0,082
Gender (A04)	Pillai's Trace	0,189	1,246	6,000	32,000	0,309
A01*A04	Pillai's Trace	0,329	1,082	12000	66000	0,389

As table 5 shows, no significant effects stemming from the position, gender or duration of service could be observed. The results of the MANCOVA do not indicate any relationship between these three characteristics and the answers to this section.

Central Hub Control

The Figures 22 and 23 show the results for the second cluster “Hub Control”. The questions (Table 6) in this section of the questionnaire aimed at examining how the cooperation of the relevant staff has changed after the introduction of a central hub control – namely the Hub Control Center. In addition, the questions were aimed at stimulating ideas for improvements in this field.

Table 6: Questions C

Item Code	Question
C01.	**Do you think that the current organization of the processes at the hub FRA is likely to have a positive influence on the outbound punctuality performance?**
C02.	**In your opinion did the introduction of a central hub control system have any influence on your personal work pressure?**
C03.	**If not, why not in your opinion?**
C04.	**Would you describe your cooperation with the central hub control as likely to have a positive influence on the overall outbound punctuality performance?**
C05.	**Do you see an urgent call for action in this field?**

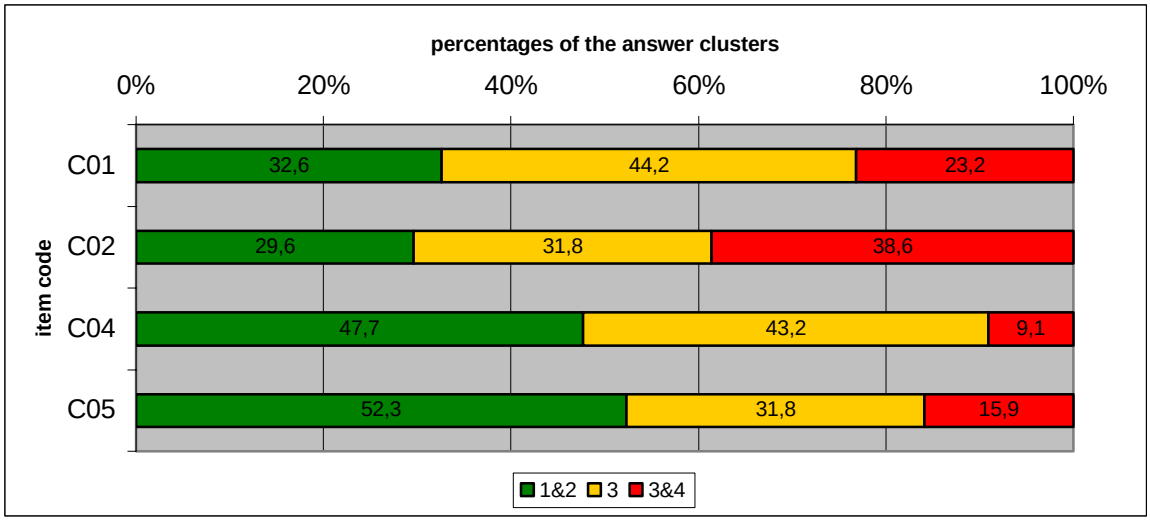


Figure 22: Central Hub Control

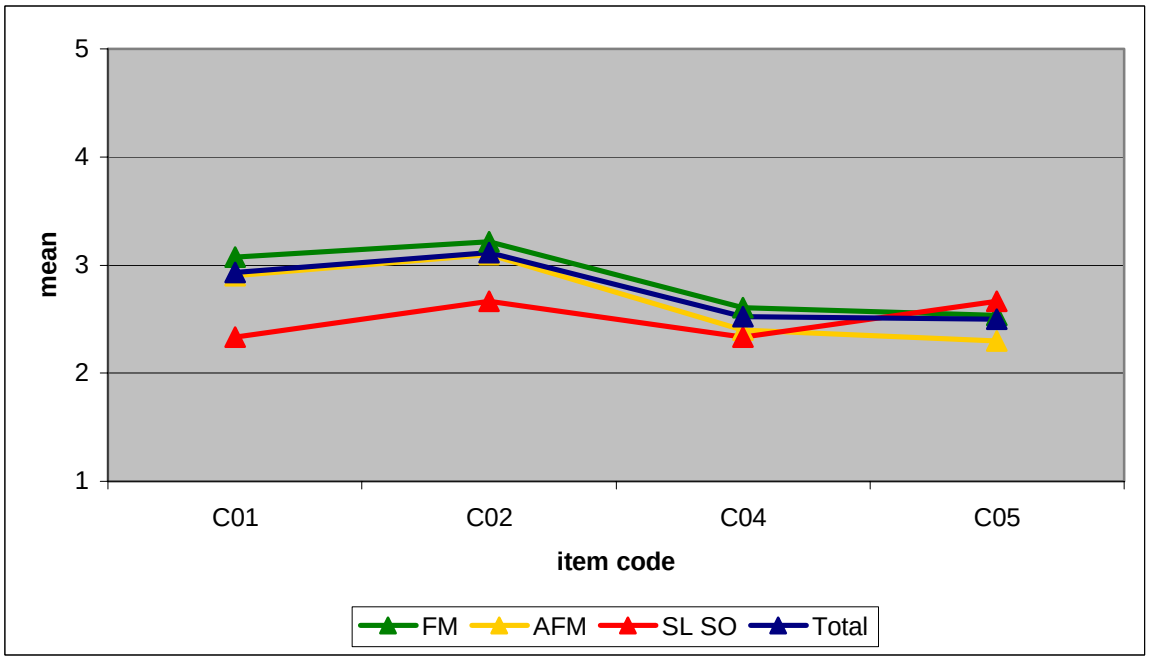


Figure 23: Means Central Hub Control

In general one can say that the answers to this cluster are relatively negative in comparison to other clusters (compare Figure 22). More than 50% of the respondents see an urgent call for action in this field. Nevertheless, the answers indicate that the respondents do not question the institution HCC in general but do see a noticeable potential for improvements. Moreover, the results for question C02 show that the introduction of the HCC has not yet had all the effects once intended.

The means in Figure 23 indicate that all groups of respondents have a similar attitude to the questions.

Table 7: Answers to Question C03

C02: In your opinion did the introduction of a central hub control system have any influence on your personal work pressure? **C03: If not, why not in your opinion?**		Responses N	Percent
	workload has not changed	4	19,0%
	lack of communication HCC <-> Shop floor	9	42,9%
	too focused on own work	1	4,8%
	HCC to far away and anonymous	1	4,8%
	too many people involved	3	14,3%
	Others	3	14,3%
Total		21	100,0%

Table 7 shows the answers to question C03 – asking for the reasons why the HCC did not have a perceivable influence on the personal workload of the respondents. As the number of responses to this open question was low the quality of the results can be questioned. However, as the later analysis will show the major point mentioned here, namely the lack of communication between the HCC and the shop floor, seems to be of central importance to the respondents of the study. This is a first indication towards an underlying problem in the process chain at the airport.

Table 8: Multivariate Tests C Section

Effect		Value	F	Hypothesis df	Error df	Sig.
Duration of Service LH (A02)	Pillai's Trace	0,152	1,473	4,000	33,000	0,233
Position (A01)	Pillai's Trace	0,141	0,644	8,000	68,000	0,738
Gender (A04)	Pillai's Trace	0,044	0,383	4,000	33,000	0,819
A01*A04	Pillai's Trace	0,071	0,313	8,000	68,000	0,959

The results of the MANCOVA (Table 8) for this section of the questionnaire do also not indicate any significant influence of the position, gender or duration of service on the responses to the questions.

Ideas & Motivation

This cluster is probably the most controversial one. It was aimed at scrutinizing whether ideas for improvements concerning the outbound punctuality are taken seriously by management and whether and how management motivates their staff. Moreover, the individual perceptions of staff's own level of motivation were to be examined. Table 9 shows the questions of this cluster.

Table 9: Questions D

Item Code	Question
D01.	**Do you contribute to the process of punctuality improvement with own ideas regularly?**
D02.	**Were any of your ideas introduced?**
D03.	**Were you notified about the decisions concerned with your idea?**
D04.	**Is outbound punctuality rewarded by your superiors?**
D05.	**Are measures taken when punctuality rules are violated?**
D06.	**Would you describe your current state of motivation towards punctuality as positive??**
D07.	**In your opinion does your personal work have any influence on the outbound punctuality performance at all?**
D08.	**Please estimate the potential improvement of punctuality within your spheres of action. (in %)**

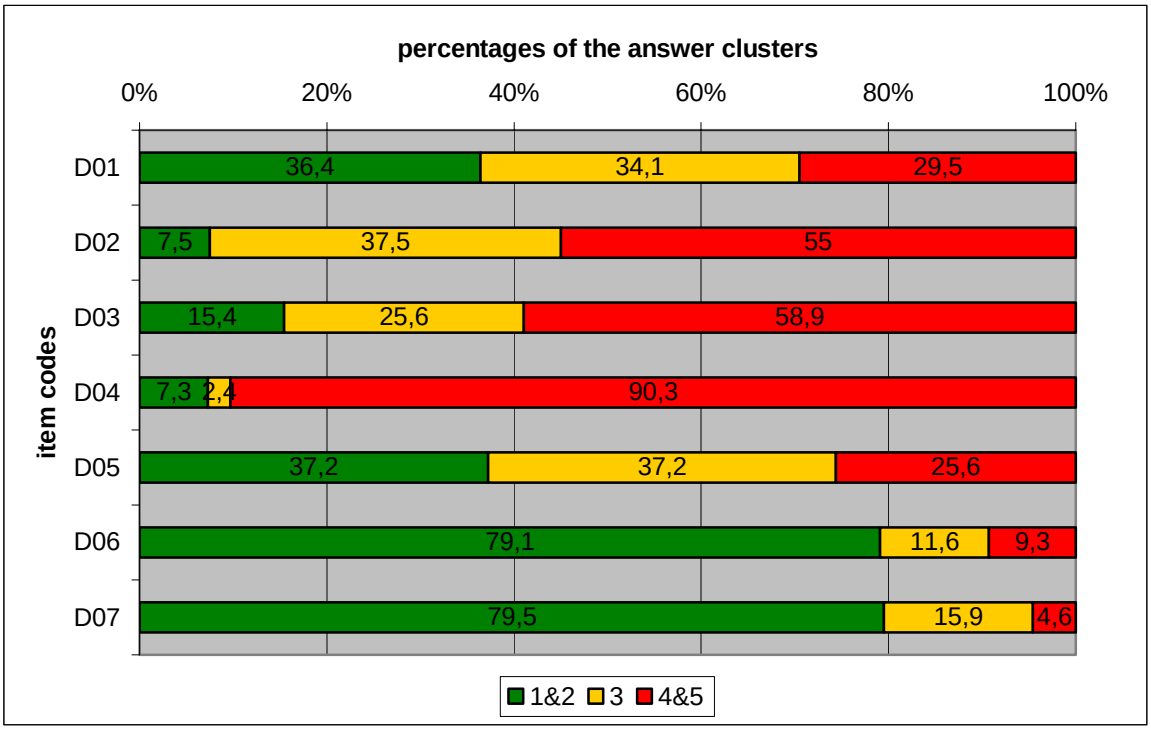


Figure 24: Ideas and Motivation

As can be seen from Figure 24 the staff seem to be well motivated regarding punctuality issues. However, they feel a lack of commitment by their superiors. Their ideas are obviously not taken seriously to the extent expected by the staff members. Moreover, a lack of communication regarding ideas once made is noticeable. Interesting in this regard is certainly the fact that there are no incentive measures rewarding outstanding punctuality performance in place yet. D04 is the question with the least positive answers in the whole survey! This point will also be subject to a detailed discussion in the following chapter.

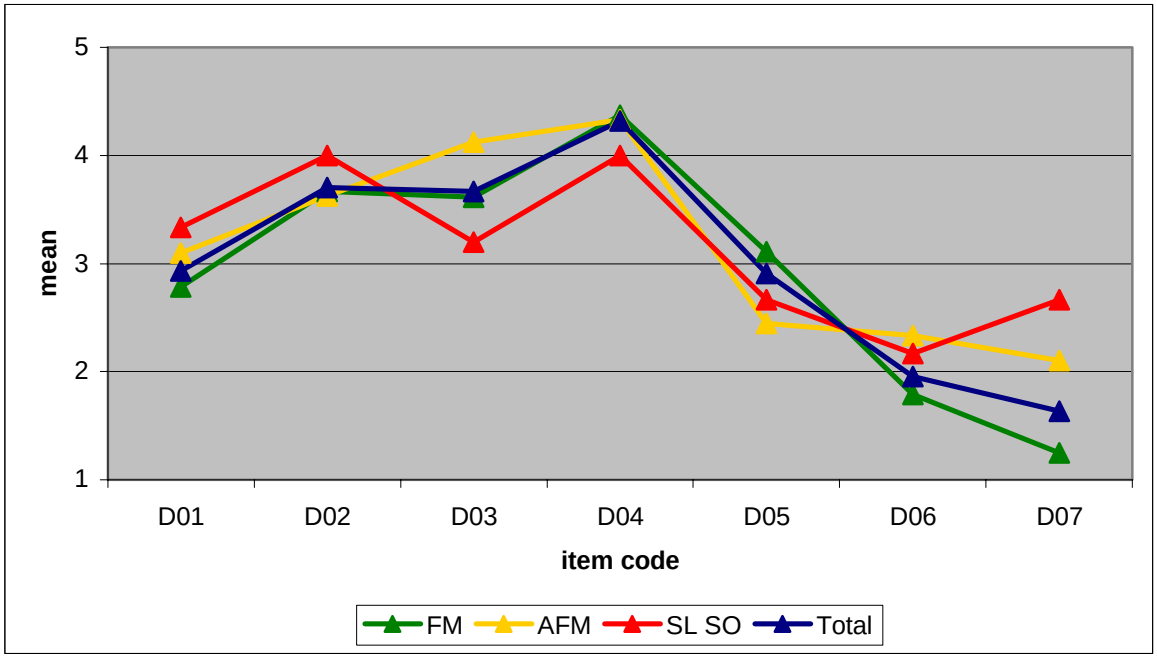


Figure 25: Means Ideas and Motivation

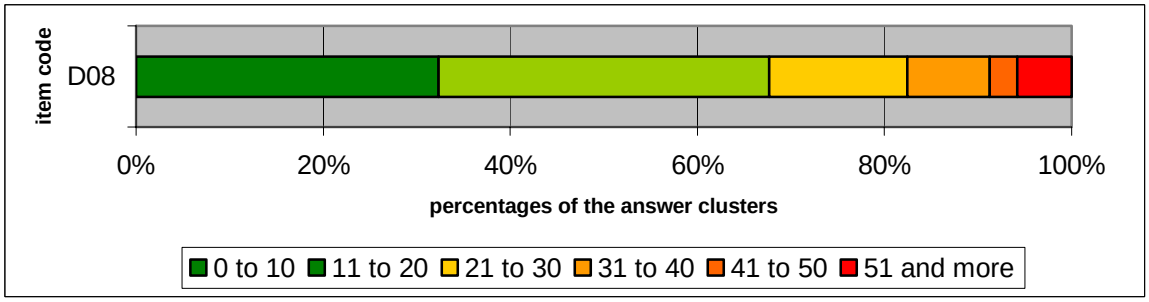


Figure 26: Results D08

Another interesting point that emerged from the answers to this cluster is the fact that almost 70% of the respondents see a potential improvement of the punctuality situation of up to 20% due to improvements in their own working environment (see

Figure 26). Also for this section the means show that the respondents have very similar attitudes towards the questions.

Table 10: Multivariate Tests D Section

Effect		Value	F	Hypothesis df	Error df	Sig.
Duration of Service LH (A02)	Pillai's Trace	0,255	1,221	7,000	25,000	0,328
Position (A01)	Pillai's Trace	0,588	1,546	14,000	52,000	0,128
Gender (A04)	Pillai's Trace	0,252	1,203	7,000	25,000	0,337
A01*A04	Pillai's Trace	0,629	1,706	14,000	52,000	0,083

In order to elaborate whether the position, gender or duration of service of the respondents have had any influence on the answers to the questions, a MANCOVA was computed. As the reader can see from table 10 no significance for any of these items was reported. It can therefore be assumed that they did not have any significant influence on the responses.

Punctuality Management

The questions in this cluster (Table 11) aimed at examining how current punctuality management is judged by the respondents. Of central interest was the interaction between the punctuality manager and the staff members. This was aimed at answering the question whether a dedicated manager for punctuality issues is potentially useful and whether and how her/ his work could be improved.

Table 11: Questions E

Item Code	Question
E01.	**Who in your opinion is the major responsible for punctuality at the hub FRA?**
E02.	**What is the name of the punctuality manager at the Lufthansa station at Frankfurt Airport?**
E03.	**Do you know about the tasks of this person closer?**
E04.	**Do you contact this person concerning punctuality relevant issues on a regular basis?**
E05.	**Did you get the assistance/ feedback you expected**
E06.	**Do you think the work of this person is important?**
E07.	**In your opinion has the work of this person had any positive influence on the punctuality performance yet?**

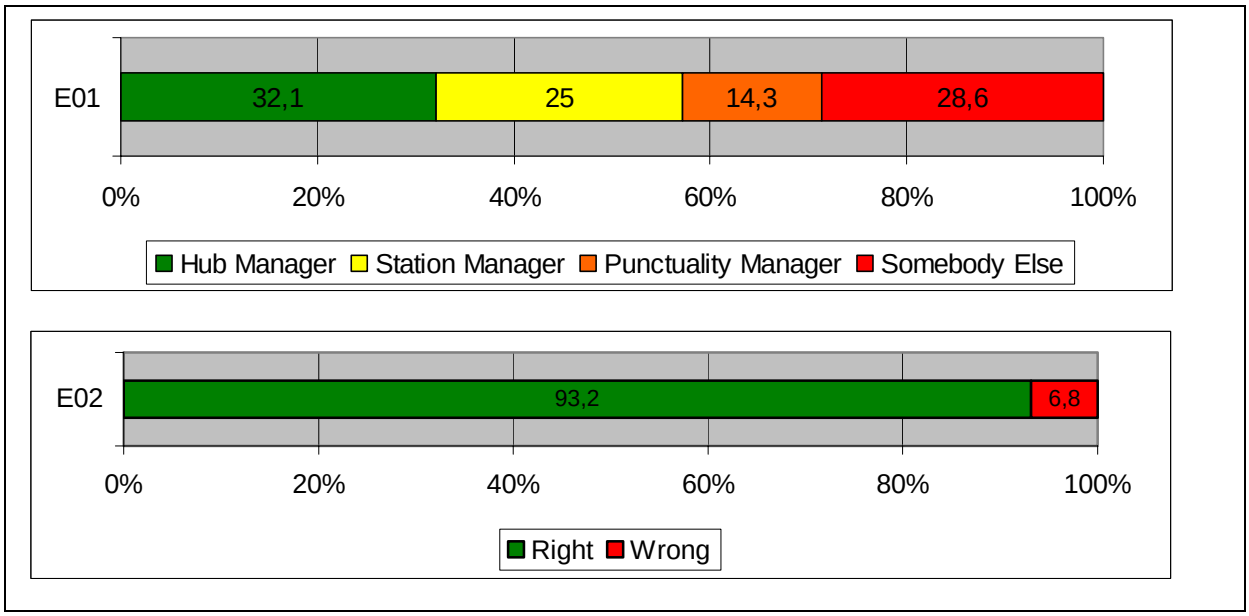


Figure 27: Answers E01 and E02

As can be seen from figure 27 a vast majority of the respondents knows the current punctuality manager at least by name. Nevertheless, 32% of the respondents ascribe the overall responsibility regarding punctuality issues to the Lufthansa Hub Manager. 25% percent of the respondents see the Station Manager as the one in charge for punctuality issues. This means, about 57% - a clear majority of the respondents assigns the major responsibility for the punctuality performance to members of the higher management.

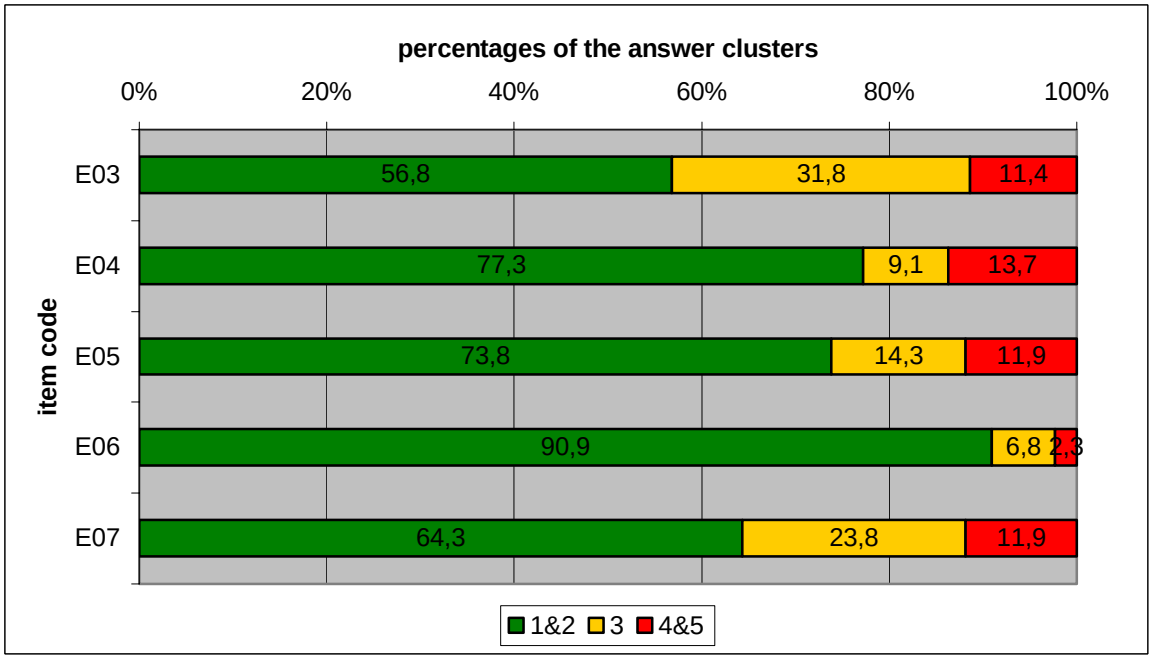


Figure 28: Punctuality Management

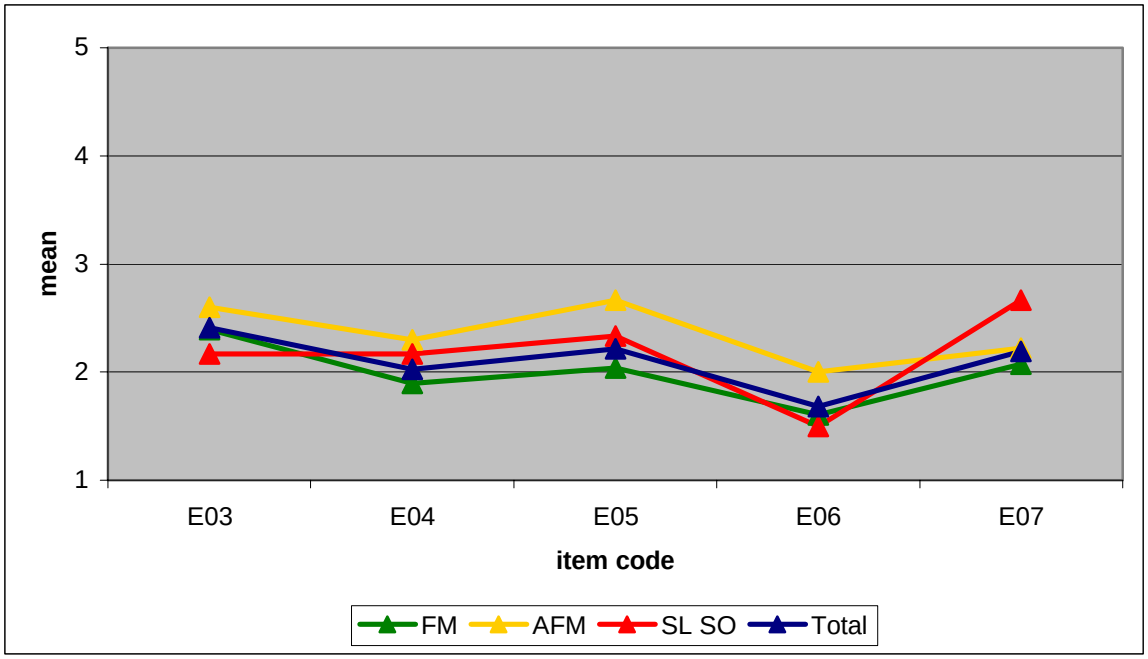


Figure 29: Means Punctuality Management

Noticeable, is the very positive overall judgment of the current punctuality management (see Figure 28). Obviously, the work of the punctuality manager is highly appreciated by the staff members. With a value of almost 91% agreement that the work of the punctuality manager is important, item E06 marks the overall maximum value in the whole survey among the questions measured on the scale from one to five. And again the means show similar attitudes across the groups of respondents.

Table 12: Multivariate Tests E Section

Effect		Value	F	Hypothesis df	Error df	Sig.
Duration of Service LH (A02)	Pillai's Trace	0,648	3,684	6,000	12,000	0,026
Postion (A01)	Pillai's Trace	0,663	1,075	12,000	26,000	0,418
Gender (A04)	Pillai's Trace	0,654	3,777	6,000	12,000	0,024
A01*A04	Pillai's Trace	0,526	0,774	12,000	26,000	0,671

As for the previous sections of the questionnaire a MANCOVA was computed for this one also. As the reader can see from table 12 the results showed significance for duration of service and gender, indicating that these issues have had a considerable

impact on the responses. In order to further scrutinize which questions were influenced between-subjects tests were computed (see table 13).

Table 13: Test of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
A02	In your opinion has the work of this person had any positive influence on the punctuality performance yet?	3,973	1	3,973	4,649	0,046
A04	Did you get the assistance/ feedback you expected?	5,538	1	5,538	7,434	0,014
	In your opinion has the work of this person had any positive influence on the punctuality performance yet?	3,964	1	3,964	4,638	0,046

The results of the between-subject tests showed significance for duration of service in item E07 (“In your opinion has the work of this person had any positive influence on the punctuality performance yet?). A comparison of the means of this item for duration of service (see table 14) showed that the longer the respondents were working with Lufthansa the worse their judgment on the influence of the work of the punctuality manager. In other words, the longer the respondents have been with Lufthansa the more they seem to be disillusioned by the effect the work of the punctuality manager has. This tendency was also experienced by the researcher when talking to older staff members.

Table 14: Comparison of Means for E07

In your opinion has the work of this person had any positive influence on the punctuality performance yet?			
Duration of employment at LH	Mean	N	Std. Deviation
9 to 14 years	1,75	4	0,957
15 to 24 years	2,06	16	0,929
longer than 25 years	2,36	22	1,049

The second significant effect was identified for gender. The results of the between subjects tests elaborated even two items that were influenced by this issue. The two items were directly linked to the perception of the work of the punctuality manager The first item was asking for the respondents perception whether the work of the punctuality manager has had any influence on the on-time performance in general (E07). The second item was concerned with the feedback / assistance the respondents receive from the punctuality manager (E05). Although both items got relatively positive responses it became evident that male respondents in both cases judged the punctuality manager better than female ones (see Figure 15). Potential reason for this might be the gender of the punctuality manager. A female punctuality manager might cause different judgments across the different genders. The author is aware of the fact that this is a rather superficial explanation. However, a clear source for this influence could not be identified.

Table 15: Comparison of Means for E07 & E05

Gender		In your opinion has the work of this person had any positive influence on the punctuality performance yet?	Did you get the assistance/ feedback you expected?
male	Mean	1,94	1,88
	N	17	17
	Std. Deviation	0,966	0,857
female	Mean	2,36	2,44
	N	25	25
	Std. Deviation	0,995	0,961

Delay Reasons

This last set of questions in the questionnaire aimed at analyzing whether the respondents' perceptions of the most critical delay reasons corresponds to the delay statistics (Table 16). In addition the transparency of the delay code allocation process was a point of interest.

Table 16: Questions F

Item Code	Question
F01.	**Which three delay codes in your opinion are the most frequent at Frankfurt Airport? (ranking 1 to 3)**
F02.	**What is the most frequent reason for delays at Frankfurt Airport in your opinion?**
F03.	**Do the delay statistics reflect the actual reasons for delays in an appropriate way?**
F04.	**Do you think that the allocation of delay codes is transparent and easily understandable?**
F05.	**If not, where do you see problems**

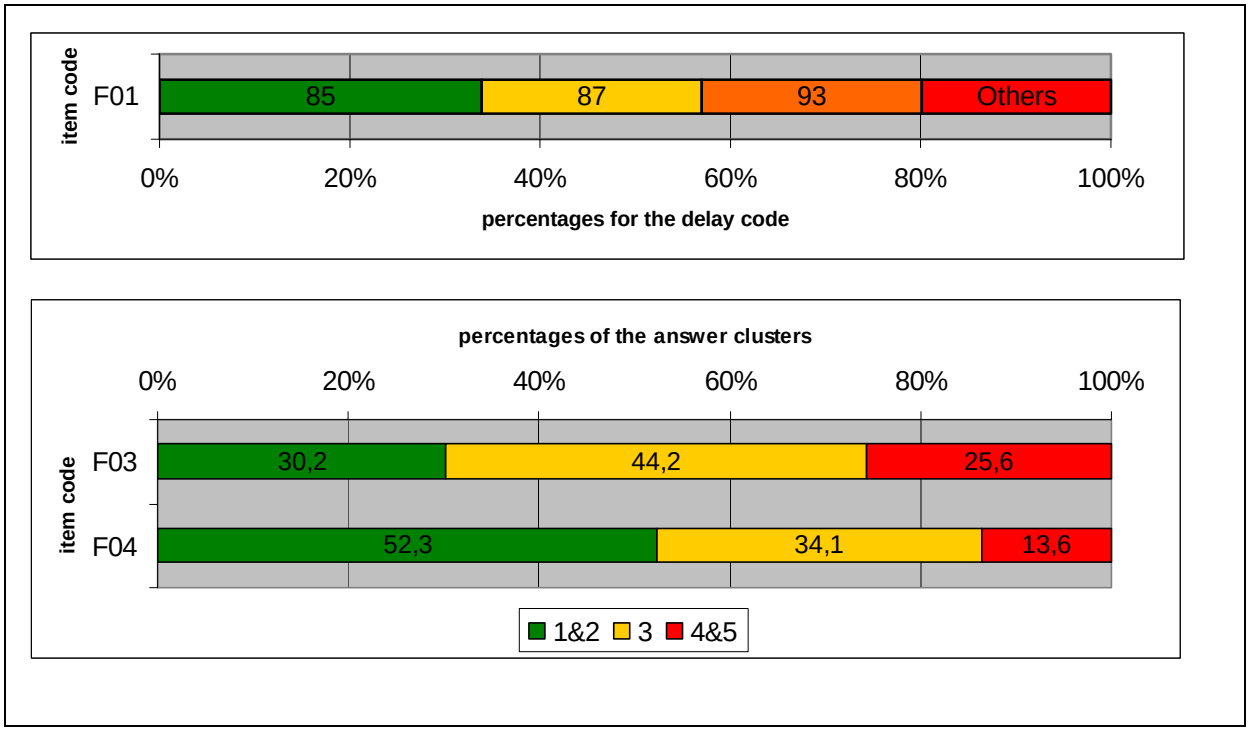


Figure 30: Delay Reasons

In their perception of the frequency of the delay codes the respondents were very close to the delay statistics. As Figure 30 shows, more than 30% saw the major

problem causally connected with Security and Airport delays (delay code 85 and 87). Moreover, rotational delays (delay code 93) were seen as dominant. This finding corresponds with the results from the delay code analysis.

However, as to the delay code allocation the values are relatively negative. Only 30% of the respondents see a clear agreement between the delay reasons as indicated by the delay statistics and the true underlying reasons in reality. This disagreement is also independent of the position of the respondents. Obviously there is a need for a closer examination of this process.

Question F02 aimed at examining which underlying “reasons” (not delay codes!) according to the respondents’ opinion are most frequent at Frankfurt Airport (see table 17). It showed that contrary to the answers to question F01, which delay codes were most frequent, a more diverse set of “reasons” was named. This seems to give evidence for that delay codes do not precisely represent the underlying reasons but do, due to their nature, group them and make them more abstract. This seems to go along with a major loss of information. It therefore seems advisable to discuss to which extent management decisions should be based on either form of information.

Table 17: Answers to Question F02

F02: What is the most frequent reason for delays at Frankfurt Airport in your opinion?	Responses	
	N	Percent
Weather	1	1,8%
A/C Rotation	4	7,3%
Crew Rotation	4	7,3%
Mandatory security baggage offload	15	27,3%
ATC/ Slot	5	9,1%
Airport Facilities/ Infrastructure	4	7,3%
Late PAX at Gate	3	5,5%
A/C Handling (Ramp)	1	1,8%
Security	6	10,9%
GSS	1	1,8%
Short ground time A/C	3	5,5%
Short connex time PAX	2	3,6%
lack of staff	3	5,5%
Late inbounds	3	5,5%
Total	55	100,0%

The number of responses to question F05 was very low as well (See Table 18). Therefore, like question C03 the quality of the data is arguable. Nevertheless, the responses once again indicate certain distrust in the delay code allocation process as well as in the communications between the HCC and the shop floor.

Table 18: Answers to Question F05

F04: Do you think that the allocation of delay codes is transparent and easily understandable? **F05: If not, where do you see problems?**		Responses	
		N	Percent
	Communication HCC <-> Shop floor	2	15,4%
	Everybody tries to put the blame onto somebody else	2	15,4%
	Glossing over the facts of the delays	5	38,5%
	Fraport loadmasters responsible for delay notification to HCC	3	23,1%
	SE/O allocates delay codes often without proper analysis	1	7,7%
Total		13	100,0%

Table 19: Multivariate Tests F Section

Effect		Value	F	Hypothesis df	Error df	Sig.
Duration of Service LH (A02)	Pillai's Trace	0,001	0,021	2,000	35,000	0,979
Position (A01)	Pillai's Trace	0,145	1,405	4,000	72,000	0,241
Gender (A04)	Pillai's Trace	0,021	0,371	2,000	35,000	0,693
A01*A04	Pillai's Trace	0,064	0,591	4,000	72,000	0,670

The MANCOVA to this last section of the questionnaire (Table 19) showed also no significant effect for either of the items gender, position, or duration of service at Lufthansa. It can therefore be assumed that these items did not have a significant impact on the answers of the respondents..

Open Question

In this very last section of the questionnaire the participants had the opportunity to express their opinions about the issue “punctuality” from a more global perspective without any restraints. They were encouraged to present their thoughts and ideas for potential improvements. Unfortunately, not all respondents took this opportunity. Therefore, a quantitative analysis of the responses seemed inappropriate. Instead, the researcher discussed the few responses from the questionnaires in the daily debriefings attended by the participants. Figure 31 represents the outcome of this informal discussion process. These were the points the Flight Mangers, Assistant Flight Managers, and Section Leaders agreed upon as to be crucial. However, the sequence of the points presented below does not indicate an order or level of importance.

G01: Place for your comments - Please feel free to write whatever you wanted to say about the outbound punctuality at Frankfurt Airport
1. Raising of the Minimum Connecting Time would help tremendously to improve the outbound punctuality especially before the backdrop of the new security measures to be introduced in the near future 2. There is a need for improvement of the reliability of the Gate Soft- and hardware (i.e. boarding control/ check-in system “Pictures”) 3. Hand luggage → outer stations allow too much hand luggage → slows down the boarding process especially on smaller A/C 4. No further tasks for the Gate staff – workload already too high 5. Lack of staff → situation is intolerable (often just 1 person per Gate) 6. Lack of communication between cockpit, cabin, Fraport, and LH station 7. Reference model too optimistic – based on unrealistic assumptions 8. Cost/ Profit vs. Punctuality – considerations often not understandable 9. Cockpit/ Cabin staff is not aware of the punctuality pressure on the ground 10. PAX guidance at the airport is poor/ distances are long/ hardware such as escalators often broken down 11. Delay code allocation of FM/ AFM should not be altered without contacting them beforehand 12. Since the FM is often not at the Gate “1. Fachkraft” should be involved/ informed about punctuality measures as well. 13. Lack of process fidelity at all stages (i.e. Matching, boarding begin) 14. No FM/ AFM does delay a departure of a flight on purpose 15. Numerous exceptions and unforeseeable events disturb the process sequence 16. Flight planning too optimistic – perfect conditions underlying → not realistic 17. High amount of transfer/ connecting PAX

Figure 31: Results G01

It became evident that the problems were not to be accounted for by a singular reason but by a set of various reasons. Three major ones could be derived: shortcomings in the communication processes, infrastructural deficits, and overall process design. These issues will get further attention in the discussion chapter

5. Discussion

The above analysis suggests that the Flight Managers, Assistant Flight Managers, and Section leaders largely agree in their assessment of the punctuality issues at the Lufthansa station at Frankfurt Airport. This chapter aims at discussing the relevant issues and will try to elaborate recommendations for potential improvements.

Communication

The statistical analysis but especially the responses to the open questions in the survey indicate that there is a lack of communication among the players in the ground handling process at Frankfurt Airport. This assessment is supported by the experiences the researcher had while observing the daily routines at the airport.

Neither the staff responsible for passenger handling (i.e. FM, AFM) nor the staff responsible for aircraft handling (i.e. SLSO, head loaders) are fully aware which information should be shared and with whom. Although there are defined communication chains in place, shortcuts are widely used, resulting in the cut off of other links in the chain. The players are not completely aware of the consequences this interruption of the information flow has.

The information processes are therefore lacking quality as well as quantity. However, the staff members are victims of these shortcomings as well. The findings suggest that they neither get the information they need nor do they give all of the information others need. The problem also extends to flight- as well as cabin crews. This communication problem probably represents the major outcome of this study and is moreover one of the central shortcomings at the hub Frankfurt. Improvement of the communication at the hub is likely to have a positive influence on the punctuality situation at the airport.

Further examination showed that there are underlying problems in the process design. From a Human Factors point of view certain communicative patterns were ignored. An example of this situation: in interviews with numerous Flight Managers, they raised concern about the following issue. According to the before-mentioned reference model, the gate staff is supposed to send the passengers through the jet way bridges at a specific time without prior notice to the crew. The only exception is if the crew has declared the aircraft “not ready for boarding” beforehand. However, the gate staff experience was that crews often forgot this announcement and passengers arrived at an aircraft with closed doors or not yet finished preparations onboard. In consequence, this procedure is mostly ignored today and the gate staff is calling for permission to begin the boarding process. This quite often delays the boarding process for a couple of minutes with negative effects for the whole process chain. The original design of the seamless process is clearly violated. The staff claim that they feel uncomfortable sending somebody into a situation that might be unpleasant for them. This is an example how uncertainty in data (Carayon, 2006) contributes to work system complexity. At this point obviously the human factor was ignored. This is just one of many examples where the communication processes hold shortcomings resulting in negative effects for the whole process chain.

This assumption is also supported by the theoretical framework presented earlier. In Vicente’s model (Vicente, 2003) of the human tech ladder, interaction and communication within and between teams plays a central role on the team and organizational level. Moreover psychological factors as the above mentioned feeling of unease do have an impact on the overall performance. Of course there are also interrelationships between the various levels. Altogether, they result in the behaviour observed – namely the violation of certain aspects of the process design. A redesign involving these considerations would therefore most certainly create a more seamless process chain finally leading to a better overall process performance.

Besides these shortcomings in the inter-human communication, the results of the observation show a second layer. Information flows within the computer networks at the station are often disrupted or lack stability. This problem is not only limited to the computer systems but to all forms of communication used at the airport. Just recently

the former radio communication system was converted into a mobile network based system. Still many of the employees complain about a lack of reliability of the system. Moreover, the handling of the new system is still causing problems. Once again a system was introduced not taking all human factors into account. The employees, for example, are critical that they miss audiovisual feedback about the actual status of their connection. For example, one cannot see which gate or flight one is currently calling, or for what reason there is no connection.

Due to the time pressure this issue becomes critical. When urgent decisions cannot be communicated to other players involved in the process on time, the whole sequence breaks down. From a theoretical Human Factors perspective this issue represents a lack of physical reliability on the lowest rung of the human tech ladder (compare Vicente, 2003). As all rungs of the ladder are based on the fulfilment of the latter, a shortcoming on the lowest level influences the stability of the whole process. This problem is also supporting Carayons (2006) thesis that the current trend towards cross-boundary working environment is creating unexpected negative effects. Therefore, there is an urgent need for improvement of the technical reliability of this essential system.

Central Hub Control

The findings of the analysis suggest that there is certain distrust among front line staff concerning the central hub control. Obviously, the introduction of the Hub Control Center did not have all the effects once intended, at least not to its full potential. The center is rather seen as some kind of “big brother” than a helpful partner. This problem is closely related to the before-mentioned communication issue. The HCC was also intended to be an information hub to ease the work for the front line staff. Instead of communicating with all relevant players in the process, the idea was to bundle the communication via the HCC. However, it seems that this is not working well. A quite large number of respondents see an urgent call for action in this field. Previous internal research carried out by Bastian Kraemer, senior personal assistant and speaker of the station manager, showed that this situation is also seen among the staff at the HCC. Both organizational entities do rather exist in parallel

rather than in a cooperative way. Although there are members of the front line staff working in the HCC as contact person there seems to be insufficient exchange between the different departments involved.

The improvement of this situation can clearly be assigned to the responsibility of the management at the station. One can certainly question whether changes in the overall organisation of the station would help here. However, the interaction between the several organizational units should be in the focus. There are a large number of potential measures that would improve the situation. A detailed account of potential measures will be presented in the last chapter.

Motivation and Feedback

The analysis of the answers of the respondents showed that they are quite well motivated, however, that they feel a lack of commitment regarding punctuality by their superiors. Many ideas that they express are not taken seriously to the extend they expect. They also claim a severe lack of feedback concerning the whereabouts of these ideas. In addition, the respondents expressed a tremendous amount of disappointment about the absence of any rewards for special punctuality performance. The non-existence of any incentive scheme is probably the underlying reason for this negative assessment. The responses support the impression that the information held by the ones involved in the daily operations is not valued and used to the extent they could expect. There is certainly potential for improvement in this field.

The importance of this issue cannot be stressed enough. Authors from various fields support the opinion that motivated staff is one key success factor for a sound performance (e.g. Niehues, et. Al., 2001). Reward structures and incentive schemes rank on the second highest level of Vicente's human tech ladder. In cooperation with a corporate culture that fosters motivation of the staff, Vicente assigns the issue central importance. This opinion is also shared by Meffert and Bruhn (2000). They claim that from a quality management perspective staff motivation is one of the most important foundations to base a lasting quality scheme on. However, the strongest

support comes from a Booz, Allen and Hamilton paper (Niehues, et. al., 2001). One of the three points to be implemented in order to promote punctuality was empowerment, motivation, and discipline. They explicitly argued that “highly motivated people, empowerment of front line staff supported by adequate incentive schemes can do more for punctual operation than millions of investment dollars”(Niehues, et. al., 2001).

However, all the before mentioned authors claim that these issues are first of all a leadership challenge. It is therefore important to address the upper and intermediate management above the level of the participants with this task.

Punctuality Management

This issue is closely related to the before mentioned one. Of course the major task of the punctuality manager is to analyse the current process design and to develop measures in order to improve the on-time performance of the airport. Moreover, the punctuality manager has the task to moderate between the different departments of the Lufthansa station. However, one of the central tasks is also to have a positive influence on the staff’s motivation.

According to the responses of the survey, punctuality management is highly valued by the employees. In particular, the communication with the punctuality manager seems to be important to the staff members. The punctuality manager therefore has a liaison function between the management and the front line staff. The daily debriefings with the Flight Managers, Assistant Flight Managers, Section Leader, and the Punctuality Manager of the station give the staff a forum to express their thoughts and experiences concerning operational issues during the day. Moreover, there they can exchange opinions. In addition, the front line staff expressed their appreciation of the daily presence of the punctuality manager at the shop floor. Although these effects can only be quantified with difficulty they help to motivate the staff resulting in positive effects concerning the overall performance.

Delay Reasons

This is a controversial issue at the Lufthansa station. All the departments within the station have a different perspective on the issue. Moreover, the perception of the staff on the shop floor does significantly differ from the one in the HCC or in the management. There are various reasons, some of which can be explained by the issues already discussed around the communication patterns.

There are basically two sub-topics involved. One is the delay code allocation; the other is the underlying delay reasons. As to the former, in the current situation the delay code allocation rather follows the delay symptoms than the delay reasons. There are two major reasons for this situation: the first is that any system trying to use standardized codes for the reflection of real events, of course is lacking sharpness. That means that you cannot have as many codes as there are possible delay reasons. In consequence, the codes actually represent clusters themselves. The second reason is closely related to the communication issues mentioned before. Today, the event-controllers in the HCC allocate the codes following the information they get. As this information is often lacking quantity as well as quality, they build up an image that misrepresents the reality. Consequently, all analyses starting from the delay code statistics run the risk of being biased.

The second topic is the actual underlying delay reasons at the airport. There are certainly as many as there are flight events at the airport. However, the author would like to discuss a few. The central issue at the airport currently is the tremendous number of delays due to security reasons – mostly baggage offloads due to missing passengers. However, as described above, this is not the actual reason for the delay but the symptom. The underlying reason is the missing passenger who is not at the gate at the time set by the reference model. This raises the question of why is the guest not there. Once again, there are numerous different reasons conceivable. The connecting time might just have been too short, or the passenger got lost in the confusing terminal, or the passenger had problems at the security check points either due to missing documents or long queuing time. As one can see, similar to a root, the reasons can be split up more and more. This is just one example out of many.

One could draw such causal chains for every delay event. However, there is no parallel information flow supporting the delay code allocation process.

Concluding this discussion, the author would like to raise a last observation that could be made at the Lufthansa station. The handling processes at the ramp have obviously come to the point where there are almost no further improvements possible under the given general conditions. In particular, the crucial luggage process is running quite smoothly. Contrary to this situation the passenger handling process shows deficits. Crucial to the whole system is the non-parallelism of the luggage and the passenger handling process. This means that the luggage flow is handled and transferred much faster than the passenger flow. In consequence this leads to a discrepancy between the passenger arrival at the gate and the loading of the luggage into the aircraft causing tremendous delays.

6. Conclusions and Recommendations

As the discussion has shown, there are manifold issues influencing the punctuality situation. Nevertheless, one always has to bear in mind that the Lufthansa operations at Frankfurt Airport rank among the best in the world and are among the top five in punctuality at a major hub in Europe. As previous research showed, it is not easy to improve the punctuality Figures above 85% (de Neufville and Odoni, 2003) on acceptable costs. The grade of training and motivation among the staff is comparatively high despite the critical circumstances under which they work. However, there are potentials for improvements which would certainly help to improve the overall situation. The following twenty recommendations can be seen as the quintessence of the study:

Communicative issues:

- Detailed analysis of the communication HCC ←→ shop floor from a Human Factors perspective
  → What information does the staff need and how should it be communicated?
  → Improvement of the technical reliability and design of the communication tools
- Redesign of the communication processes where necessary
- Workshops with front line staff from all departments involved under supervision of external Human Factors experts in order to promote the mutual understanding
  → Similar programs do exist already with pilots and cabin crew staff (e.g. CRM)
- Daily debriefings with staff from the shop floor together with HCC staff in order to jointly come to terms with the delay events of the day.
- Involvement of staff members below the operational executives in the punctuality discussion as well
  → As many flights are handled without physical supervision of the operational executives, the staff on lower levels needs to be informed and trained concerning punctuality as well.

- Strengthening of the vertical communication at the Lufthansa station
  → Communication between superiors and front line staff should be intensified in order to foster a fruitful dialog about punctuality issues.
- Strengthening of the horizontal communication between the departments at the station
  → Extension of the existing communication to lower levels of the hierarchy in order to create a strong information network on all levels.

Strategic issues:

- Elucidation of the management commitment towards punctuality
- Lasting establishment of the punctuality management as an integrated part of the central management: extension of the necessary authority and means for intervention
- Promotion of departure punctuality as added value for the guest
- Regularity vs. Punctuality → transparent trade off decisions in order to regain network control after extensive delay events
- Individual adjustment of the product → definition of realistic minimum connecting times
- Transfer of competences where they belong – back to shop floor or into HCC
- Introduction of an incentive scheme around punctuality issues

Operational issues:

- Improvement of the PAX flow management → terminal guidance (e.g. signs)
- Remodeling of the reference charts under realistic assumptions (e.g. time for flight closure)
- Intensified training concerning punctuality issues for all relevant staff
- Earlier scheduling of critical links in the process chain → gate should not be the place for problem solving activities

The above – mentioned issues are certainly neither all-embracing nor do they represent a universal plan for punctuality improvements. They should rather be seen as potential topics to start from, which in connection with others could help to use the potential existing in the organization. The whole is too complex to just adjust a few levers in order to improve the punctuality performance. Nevertheless, following the before – mentioned recommendations will certainly contribute to the improvement process. Moreover, findings of this study raised several issues that require further research, e.g. process design under Human Factors considerations.

Concluding the author would like to remind the reader where this study started. The intention of this study was to examine the perceptions, attitudes, and knowledge of the operational executives at the Lufthansa station in Frankfurt. It became evident that they hold important information and useful ideas. Moreover, they seemed to be quite well motivated. Nevertheless, shortcomings in the communication system were identified resulting in various further issues. Furthermore, management commitment towards punctuality is obviously not very clear to the staff members. Following the recommendations above should help to improve the overall on-time performance noticeably. This does not mean that the author recommends pampering the staff members but to recognize the potential they hold.

The central lesson to be learnt is therefore the realization that staff holds very useful and valuable information for the management of the whole organization. This source of knowledge should not be ignored any longer but be exploited. Ignoring this knowledge might have dramatic consequences. This may cost time and even money; however, not using this information would certainly cost more. Or freely adapted from Bok: if you think gathering knowledge is expensive try ignorance.
In this sense the author would like to wish the reader

- ***Always happy landings –***

The author

Joerg Speri was born the 1st of May 1979 in East Germany, formerly German Democratic Republic. He graduated from High School in 1997. After serving in the German Armed Forces for two years, he began his studies at Dresden University of Technology, at the Institute for Transportation Sciences “Friedrich List”. His studies focused on transportation management and technology. In 2002 Joerg Speri moved to Mid Sweden University. There he graduated now holding a Bachelor as well as a Masters degree in Business Administration. During his studies in Sweden he specialized in international management, cross-cultural marketing and organization.
Since 2004 Joerg Speri has been studying for a Masters degree in Aviation at Massey University, Auckland, New Zealand. He is employed with Lufthansa German airlines since 2005, currently in the position of Manager Strategy and Product Management at the Lufthansa Technical Division - Aircraft Overhaul and VIP Jet Services in Hamburg, Germany.

References

Ashford, N., Stanton, H. P. M., Moore, C. A. (1997). *Airport Operations (Second edition)*. Boston: McGraw-Hill.

Association of European Airports: www.aea.org. 2005.

Boff, K. R. (2006). Revolutions and shifting paradigms in Human Factors & ergonomics, *Applied Ergonomics, 27(2006), pp. 391-399.*

Booth, R. T. (1996). The promotion and measurement of a positive safety culture. In N. Shanton (Ed.), *Human Factors in Nuclear Safety*. Southampton: Taylor & Francis.

Beauvois J.L., Joule R.V., *Capacité de mobilisation des ménages en matière d'économies d'énergie, Rapport Final, 2000*.

Carayon, P., Smith, M. J. (2000). Work organization and ergonomics, *Applied Ergonomics, 31 (2000), pp.649-662.*

Carayon, P. (2006). Human Factors of complex sociotechnical systems, *Applied Ergonomics, 37 (2006), pp. 525-535.*

De Neufville, R., Odoni, A. (2003). *Airport Systems: Planning, Design, and Management.* London: McGraw-Hill.

Doganis, R. (a) (2002). *Flying Off Course – The economics of International Airlines*. London: Harper Collins Academic.

Doganis, R. (b) (2002). *The Airport Business*. New York: Routledge.

Eichner, E. R. (1997). Erogenic aids: what athletes are using – and why, *Physicians Sports Medicine,* 25(4).

Flach, J., Hancock, P., Caird, J., Vicente, K. (1995). *Global Perspectives on the Ecology of Human Machine Systems.* Hillsdale: Erlbaum

Fraport: www.fraport.de. 2005.

Friedman, T. L. (2005). *The World is Flat: A brief History of the Twenty-first Century.* New York: Farrar, Strauss & Giroux.

Friedman J.L., Fraser S.C. (1966), Compliance without pressure: The foot-in-the-door technique, *Journal of Personality and Social Psychology*, 4, 195-202.

Herbst, A. (1977). *Pünktlichkeit als Kriterium der Qualität von Personenbeförderungs-leistungen im Luftverkehr*. Dresden: Diplomarbeit.

Human Factors Society: www.hfes.org/WEB/AboutHFES/history.html. 2006

Horkheimer, M. (1982). *Critical Theory*. New York: Seabury Press.

Horkheimer, M. (1993). *Between Philosophy and Social Science*. Cambridge: MIT Press.

International Air Transport Association: www.iata.org. 2005.

Jastrzebowski, W. (1857). *An Outline of Ergonomics or the Science of Work based upon the Truths drawn from the Science of Nature.* Warsaw: Central Institute of Labor Protection Poland

Jensen, R.S. (1997). The boundaries of aviation psychology, Human Factors, aeronautical decision making, situation awareness, and crew resource management, *The International Journal of Aviation Psychology, 7(4), pp. 259-267.*

Kishon, E. (2001). Ein Profi am Steuer, *Beste Autofahrergeschichten*. Berlin: Bastei Lübbe.

Klein, G. A. et. al. (1993). *Decision Making in Action: Models and Methods*. Norwood: Ablex Publishing.

Koonce, J. M. (1984). A brief history of aviation psychology, *Human Factors*, 26, pp. 499-508.

Lufthansa: Intranet. 2005.

Maurino, D. E., et al. (1995). *Beyond aviation Human Factors: safety in high technology Systems.* London: Avebury Aviation.

Meffert, H.; Bruhn, M. (2000). *Dienstleistungsmarketing – Grundlagen, Konzepte, Methoden*. Wiesbaden: Gabler.

Meister, D. (1999) *The History of Human Factors and Ergonomics*. New Jersey: Erlbaum.

Moray, N. (2000). Culture, politics, and ergonomics, *Ergonomics, 43 (7), pp. 858-868.*

Niehues, A., et. al. (2001). *Punctuality: How Airlines can improve On-Time Performance.* Booz, Allen & Hamilton. London.

Rasmussen, J., Pejtersen, A. M., Goodstein, L. P. (1994). *Cognitive Systems Engineering.* New York: Wiley.

Rasmussen, J. (2000). Human Factors in a dynamic information society: where are we heading?, *Ergonomics, 43 (7), pp. 869-879.*

Reason, J. (1990). *Human error*. New York: Cambridge University Press

Roscoe, S. N. (1997). The Adolescence of Engineering Psychology In S. Casey (Ed.), *Human Factors History Monograph Series*. The Human Factors Society. Santa Monica.

Salvendy, G. (Ed.) (1997). *Handbook of Human Factors*. New York: Wiley.

Seashore, S.E. (1997). Surveys in Organizations. In G. Salvendy (Ed.), *Handbook of Human Factors.* New York: Wiley.

Shaw, S. (2004). *Airline Management and Marketing* (*Fourth edition)*. Aldershot: Ashgate Publishing Ltd.

Smith, K. (1987). Origins of Human Factors Science, *Human Factors Society Bulletin,* 30(4), pp. 1-3.

Van Steen, Jaques (1996). *Safety Performance Measurement.* Warwickshire: Institution of Chemical Engineers.

Vicente, K. (1999). *Cognitive Work Analysis.* Mahwah: Erlbaum.

Vicente, K. (2003). *The Human Factor – revolutionizing the way people live with technology*. New York: Routledge.

Wilson, J. R. (2000). Fundamentals of ergonomics in theory and practice, *Applied Ergonomics, 31 (6), pp. 557-567.*

Yin, R.K. (1994). *Case Study Research - Design and Methods (second edition).* Thousand Oaks: Sage Publications.

Appendix I

The Questionnaire

A. General Questions

A01.	Are you?		
	☐ FM	☐ AFM	☐ SL SO

A02.	How long have you been working for Lufthansa?				
	< 3 Years	3 – 8 Years	9 – 14 Years	15 – 24 Years	25 < Years
	☐	☐	☐	☐	☐

A03.	How long have you been working in your current position??				
	< 3 Years	3 – 8 Years	9 – 14 Years	15 – 24 Years	25 < Years
	☐	☐	☐	☐	☐

A04.	Are you?	
	☐ male	☐ female

B. Information/ Communication

		Yes	rather Yes	So So	rather No	No
		❶	❷	❸	❹	❺
B01.	Are you notified about the current status and the changes of the outbound punctuality quality on a regular basis?	☐	☐	☐	☐	☐
B02.	Do you discuss punctuality issues with your colleagues regularly?	☐	☐	☐	☐	☐
B03.	Do you discuss punctuality issues with your superiors regularly?	☐	☐	☐	☐	☐
B04.	Are you notified about newly introduced punctuality measures regularly?	☐	☐	☐	☐	☐
B05.	Are employees trained for outbound punctuality on a regular basis?	☐	☐	☐	☐	☐
B06.	Do you get feedback about punctuality relevant incidents?	☐	☐	☐	☐	☐

C. Central Hub Control

		Yes	rather Yes	So So	rather No	No
		❶	❷	❸	❹	❺
C01.	**Do you think that the current organization of the processes at the hub FRA is likely to have a positive influence on the outbound punctuality performance?**	☐	☐	☐	☐	☐
C02.	**In your opinion did the introduction of a central hub control system have any influence on your personal work pressure?**	☐	☐	☐	☐	☐
C03.	**If not, why not in your opinion?**					
C04.	**Would you describe your cooperation with the central hub control as likely to have a positive influence on the overall outbound punctuality performance?**	☐	☐	☐	☐	☐
C05.	**Do you see an urgent call for action in this field?**	☐	☐	☐	☐	☐

D. Ideas & Motivation

		Yes	rather Yes	So So	rather No	No
		❶	❷	❸	❹	❺
D01.	**Do you contribute to the process of punctuality improvement with own ideas regularly?**	☐	☐	☐	☐	☐
D02.	**Were any of your ideas introduced?**	☐	☐	☐	☐	☐
D03.	**Were you notified about the decisions concerned with your idea?**	☐	☐	☐	☐	☐
D04.	**Is outbound punctuality rewarded by your superiors?**	☐	☐	☐	☐	☐
D05.	**Are measures taken when punctuality rules are violated?**	☐	☐	☐	☐	☐
D06.	**Would you describe your current state of motivation towards punctuality as positive?**	☐	☐	☐	☐	☐
D07.	**In your opinion does your personal work have any influence on the outbound punctuality performance at all?**	☐	☐	☐	☐	☐
D08.	**Please estimate the potential improvement of punctuality within your spheres of action. (in %)**					

E. Punctuality – management

		Yes ❶	rather Yes ❷	So So ❸	rather No ❹	No ❺
E01.	**Who in your opinion is the major responsible for punctuality at the hub FRA?**					
E02.	**What is the name of the punctuality manager at the Lufthansa station at Frankfurt Airport?**					
E03.	**Do you know about the tasks of this person closer?**	☐	☐	☐	☐	☐
E04.	**Do you contact this person concerning punctuality relevant issues on a regular basis?**	☐	☐	☐	☐	☐
E05.	**Did you get the assistance/ feedback you expected**	☐	☐	☐	☐	☐
E06.	**Do you think the work of this person is important?**	☐	☐	☐	☐	☐
E07.	**In your opinion has the work of this person had any positive influence on the punctuality performance yet?**	☐	☐	☐	☐	☐

F. Delay reasons

		Yes ❶	rather Yes ❷	So So ❸	rather No ❹	No ❺
F01.	**Which three delay codes in your opinion are the most frequent at Frankfurt Airport? (ranking 1 to 3)**					
F02.	**What is the most frequent reason for delays at Frankfurt Airport in your opinion?**					
F03.	**Do the delay statistics reflect the actual reasons for delays in an appropriate way?**	☐	☐	☐	☐	☐
F04.	**Do you think that the allocation of delay codes is transparent and easily understandable?**	☐	☐	☐	☐	☐
F05.	**If not, where do you see problems**					

Place for your comments – Please feel free to write whatever you wanted to say about the outbound punctuality at Frankfurt:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Thank you very much for your support!!!

Appendix II

LH Subdelay-Codes (21. April 2005)

	Main-Delay-Code		IATA Sub-Delay-Code LH internal Sub-Delay-Code	Used LH	Remarks
AIRLINE INTERNAL CODES					
1	**ONLY TO BE USED BY OPERATIONS CONTROL CENTER**				
2	**Load connection while waiting for AFTM or MISSED SLOT**				
3	**DELAY TIME DISCREPANCIES UP TO 3 MINUTES automatically initiated by A/C equipped with Datalink facility**				
4	**LACK OF AIRCRAFT due to additional revenue flights out of operational reserve or maintenance reserve capacity/version not in line with booking Figures**				
5	**INADEQUATE GROUND TIME ON NPI SERVICES, up to 5 minutes; applicable until further notice only on 25 minutes ground time**				
8	**ACTUAL BLOCK TIME OF INCOMING AIRCRAFT ABOVE SCHEDULED BLOCK TIME**				
IATA STANDARD CODES					
	OTHERS				
6	**NO GATE/STAND AVAILABILITY DUE TO OWN AIRLINE ACTIVITY**				

9	**SCHEDULED GROUND TIME LESS THAN DECLARED MINIMUM GROUND TIME**				
		A	TECHNICAL	x	
		B	COMMERCIAL	x	
		C	PLANNED		
	PASSENGER AND BAGGAGE				
11	**LATE CHECK-IN, acceptance after deadline**				
		A	LATE GATE CHECK IN OF TRANSFER PAX	x	IN SPITE OF SUFFICIENT TRANSFER TIME
		B	WAITINGLIST PROCESSING	x	
		C	LATE ACCEPTANCE OF OK BOOKED PAX	x	
		D	LACK OF STAFF	x	
		E	GROUP CHECK-IN	x	
		F	GROUND TRANSPORTATION/AIRPORT ACCESS CONGESTION/CLOSURE		MOVE TO 87
12	**LATE CHECK-IN, congestion in check-in area**				
		A	CONGESTION IN CHECK-IN AREA	x	Departure Hall only
		B	LACK OF STAFF	x	CKI only
		C	CONGESTION IN TRANSFER AREA	x	
		D	GROUP CHECK-IN	x	
		E	GROUND TRANSPORTATION/AIRPORT ACCESS CONGESTION/CLOSURE		MOVE TO 87
		F	WAITINGLIST PROCESSING	x	
		R	LACK OF STAFF: SPECIAL ASSISTANCE	x	
		S	LACK OF STAFF: SUPERVISION	x	
		T	LACK OF STAFF: TICKETING	x	
13	**CHECK-IN ERROR, passenger and baggage (incorrectly processed)**				
		A	CHECK IN ERROR - STATION	x	

		B	CHECK IN ERROR - THROUGH CHECK-IN		LH USE 92
		C	CHECK IN ERROR - RETURN FLIGHT CHECK-IN		LH USE 92
		D	CHECK-IN ERROR - CURBSIDE		
		E	CHECK-IN ERROR - KIOSK	x	
		F	CHECK-IN ERROR - TELEPHONE	x	
		G	CHECK-IN ERROR - INTERNET	x	
		H	CHECK-IN ERROR - OFF AIRPORT TERMINAL	x	
		I	CHECK-IN ERROR - HOTEL	x	
		J	CHECK-IN ERROR - INTERMODAL (E.G. SHIP/TRAIN ETC)	x	
		K	DOUBLE SEATING/DOUBLE CHECK-IN	x	
		L	DOCUMENTATION (TICKET/VISA/PASSPORT ETC)	x	
14	**OVERSALES, booking errors**				
		A	OVERSALES	x	
		B	BOOKING ERROR	x	
		R	CONFIGURATION CHANGE COMMERCIAL REASONS	x	
		S	INVOLUNTARY DOWNGRADING/Upgrading OF PASSENGERS	x	
		T	OFFLOADING OF OK PASSENGERS incl. Bag	x	
		U	VDB PASSENGERS	x	
		V	ETIX BOOKING ERROR	x	
		W	ACCOMODATING PAX FROM OTHER OVERSOLD FLIGHTS	x	
15	**BOARDING, discrepancies and paging, missing checked-in passenger without baggage offload**				
		A	BOARDING ERROR / PAX FIGURES DISCREPANCIES	x	
		B	LATE BOARDING	x	
		C	SLOW BOARDING	x	
		D	MISSING / LATE CHECK-IN PAX (WITHOUT BAGGAGE)	x	

		E	LATE BUS ORDER/RELEASE BY GATE	x	
		F	DOCUMENTATION (TICKET/VISA/PASSPORT ETC)	x	
		G	LACK OF STAFF	x	
		H	HEADCOUNT DISCREPANCY		CREW DELAY
		I	EXCESS HANDLUGGAGE HANDLING	x	
		R	LATE DOC-CHECK STAFF	x	THIRD PARTY
		S	LATE LOAD SHEET AT GATE	x	Caused by CKI staff
		T	LATE SPECIAL ASSISTANCE (SANI) ORDER	x	
		U	RESEATING PAX AFTER VERSION OR EQUIPMENT CHANGE	x	after NIF in order to avoid boarding discrepancies
		V	DELAYED BOARDING HON CIRCLE	X	
16	**COMMERCIAL PUBLICITY/PASSENGER CONVENIENCE, VIP, press, ground meals and missing personal items**				
		A	VIP BOARDING	x	
		B	DISRUPTIVE PAX HANDLING	x	
		C	DISABLED PAX HANDLING	x	
		D	MISSING PERSONAL ITEMS	x	
		E	DEPO/INAD HANDLING	x	
		F	GROUND MEALS (E.G. DELAYED FLIGHT)		Gate Service
		G	PASSENGER REQUESTED OFFLOAD	x	without baggage
		H	ILLNESS/DEATH OF PASSENGER	x	
		R	COMMERCIAL PUBLICITY/PRESS OR TV	x	
		S	PAX ACCEPTANCE FROM OTHER CARRIER NOT CONNECTING	x	
17	**CATERING ORDER, late or incorrect order given to supplier**				
		A	LATE ORDER	x	
		B	INCORRECT ORDER	x	

		C	LATE ORDER OF NON STANDARD SUPPLIES (E.G. BLANKETS, HEADPHONES ETC.)		use code 68 T
		R	LATE ORDER OF ADD. RETURN CATERING BY DEST.	x	
18	**BAGGAGE PROCESSING, sorting, etc.**				
		A	LATE DELIVERY LOCAL BAGGAGE	x	
		B	LATE DELIVERY TRANSFER BAGGAGE	x	more actual time than MCT
		C	BAGGAGE RECONCILATION		USE LH own codes below
		D	LACK OF STAFF	x	
		R	BREAKDOWN BRS	x	
		S	BRS ERROR DUE TO MATCHING DISCREPANCIES	x	
		T	LATE DELIVERY BULKY BAGGAGE	x	
		U	LATE DELIVERY BAGGAGE FROM GATE	x	
		V	BREAKDOWN AUTOMATED BAGGAGE TRANSPORTATION SYSTEM	x	
		W	SCANNING X-RAY	x	
	CARGO AND MAIL				
21	**DOCUMENTATION (late or incorrect)**				
		A	LATE CARGO FIGURES	x	
		B	INCORRECT CARGO FIGURES	x	
		C	LATE CARGO DOCS	x	
		D	INCORRECT CARGO DOCS	x	
		R	LATE OR INCORRECT NOTOC	x	
22	**LATE POSITIONING (discrepancies)**				
		A	RELOADING A/C DUE TO MISSING CARGO	x	
		B	LACK OF STAFF	x	
		C	LACK OF EQUIPMENT	x	

		D	POSITIONED TO WRONG STAND	x	
		R	INCORRECT CONTOUR/BUILT UP OF ULD	x	Wrong Container for A/C
23	**LATE ACCEPTANCE (after deadline)**				
		A	LATE ACCEPTANCE CGO - COMMERCIAL REASONS	x	
		B	ACCEPTANCE OF STANDBY CARGO	x	
		C	LACK OF STAFF	x	
		D	EXPRESS CARGO	x	
		E	DIPLOMATIC MAIL	x	
24	**INADEQUATE PACKING or inadequate provision of loading material**				
		A	LOAD SHIFTING ENROUTE TO AIRCRAFT	x	
		B	DANGEROUS GOODS	x	
		C	INCORRECT PALLET BUILT-UP (E.G. OVERLAPS)	x	
		R	LTE PROVISION OF LOADING OR LASHING MATERIAL	x	material necessary for e.g. HEA, etc.
25	**OVERSALES, booking errors**				
		A	OVERSALES	x	
		B	BOOKING ERROR	x	
		C	ACCEPTANCE OF STANDBY CARGO		
26	**LATE PREPARATION IN WAREHOUSE**				
		A	PALLETISING ERRORS	x	
		B	CONTOURS	x	
		C	CARGO SYSTEM FAILURES	x	
		D	LACK OF STAFF	x	
		E	WAREHOUSE CONGESTION	x	

	MAIL ONLY				
27	**DOCUMENTATION, PACKING, etc.**				
		A	LATE MAIL FIGURES	x	
		B	INCORRECT MAIL FIGURES	x	
		C	LATE DOCS	x	
		D	INCORRECT DOCS	x	
		R	DISCREPANCIES BTN ESTIMATED AND POSITIONED MAIL	x	
28	**LATE POSITIONING**				
		A	RELOADING AIRCRAFT DUE TO MISSING MAIL	x	
		B	LACK OF STAFF	x	
		C	LACK OF EQUIPMENT	x	
		D	POSITIONED TO WRONG STAND	x	
		R	DAMAGED OR INCORRECT BUILT UP OF ULD	x	
29	**LATE ACCEPTANCE**				
		A	LATE ACCEPTANCE MAIL - COMMERCIAL REASONS	x	
		B	ACCEPTANCE OF STANDBY MAIL	x	
		C	LACK OF STAFF	x	
	AIRCRAFT AND RAMP HANDLING				
31	**AIRCRAFT DOCUMENTATION LATE/INACCURATE, weight and balance, general declaration, pax manifest, etc.**				
		A	LATE DOCUMENTATION	x	
		B	INCORRECT DOCUMENTATION	x	
		C	LATE LOADSHEET	x	

		D	INCORRECT LOADSHEET	x	
		E	REPOSITIONING OF PASSENGERS/DEADLOAD FOR BALANCE REASONS	x	
		F	INCORRECT DATA IN DCS SYSTEM (E.G. SEATPLAN)	x	
		G	LACK OF STAFF	x	
		H	LOADING-PLAN ERROR	x	
		I	LATE FUEL FIGURES	x	
		R	AMENDING DOCUMENTS DUE TO LAST MINUTE CHANGES DUE TO PAX	x	
		S	LATE PRESENTATION OF FLIGHT DOCUMENTS TO COC BY HANDLING AGENT	x	
		T	LATE REMOTE LOADSHEET	x	
32	**LOADING/UNLOADING, bulky, special load, cabin load, lack of loading staff**				
		A	CABIN LOAD; BULKY; SPECIAL LOAD; HEA	x	
		B	LATE LOADERS	x	
		C	LACK OF STAFF	x	
		D	INCORRECT LOADING (NOT ACCORDING TO LOADPLAN OR LOADING PRINCIPLES)	x	
		E	ULD DAMAGE	x	
		F	INPLANE LOADING SYSTEMS INOPERABLE		use 41D
		G	LATE/LACK OF LOADING DEVICES (LASHING AND / OR SUPPORTING MATERIAL)	x	e.g. for AVIH and other baggage
		R	VOLUMETRIC/SPACE PROBLEMS	x	incl. bulk load
		S	ADJUSTING LOADING DUE TO LAST MINUTE CHANGES	x	
33	**LOADING EQUIPMENT, lack of or breakdown, e.g. container pallet loader, lack of staff**				
		A	LATE EQUIPMENT	x	
		B	LACK OF EQUIPMENT	x	

		C	LACK OF EQUIPMENT OPERATOR	x	
		D	BREAKDOWN OF EQUIPMENT	x	
		E	INCORRECT EQUIPMENT	x	
34	**SERVICING EQUIPMENT, lack of or breakdown, lack of staff, e.g. steps**				
		A	LATE/LACK/BREAKDOWN OF JET-WAY	x	in case of breakdown use 87 E
		B	LATE/LACK OF PAX STAIRS	x	
		C	LATE/LACK OF PASSENGER TRANSPORT	x	
		E	LATE/LACK OF WATER SERVICE	x	
		F	LATE/LACK OF TOILET SERVICE	x	
		G	LACK OF STAFF	x	
		R	LATE OR LACK OF AMBULANCE	x	
		S	LATE DELIVERY LOWER CREW REST UNIT	x	
		T	LATE PASSENGER TRANSPORT COMPARTMENT	x	
35	**AIRCRAFT CLEANING**				
		A	LATE COMPLETION	x	
		B	INSUFFICIENT OR INCORRECT EQUIPMENT	x	
		C	EQUIPMENT BREAKDOWN	x	
		D	LACK OF STAFF	x	
		E	CALLED BACK TO AIRCRAFT		SAME AS F-ADDITIONAL CLEANING
		F	ADDITIONAL OR SPECIAL CLEANING REQUIRED	x	
		G	COCKPIT WINDOW CLEANING	x	
		H	LATE OR LACK OF CABIN SUPPLIES (E.G. BLANKETS, HEADREST COVERS, ETC.)	x	
36	**FUELLING/DEFUELLING, fuel supplier**				
		A	LACK OF FUEL TRUCK	x	
		B	LATE FUEL TRUCK	x	
		C	BREAKDOWN OF FUEL TRUCK DURING OPERATION	x	

		D	DEFUELLING	x	
		E	LACK OF STAFF	x	
		F	FUELLING ERROR	x	
		G	SPECIAL PROCEDURE FOR TECHNICAL REASONS		IF TECHNICAL USE 41
		H	FUEL HYDRANT SYSTEM		use 87?
		I	FUEL SHORTAGE/CONTAMINATION	x	
		J	FUEL SPILL AT AIRCRAFT	x	
		K	INCORRECT PARKING OF AIRCRAFT - UNABLE TO FUEL	x	
37	**CATERING, late delivery or loading**				
		A	LACK OF CATERING / SUPPLIER STAFF	x	
		B	LACK OF CATERING EQUIPMENT	x	
		C	BREAKDOWN OF CATERING EQUIPMENT	x	
		D	LATE CATERING	x	
		E	WRONG OR INSUFFICIENT CATERING (INCL. CABIN ITEMS E.G. BLANKETS)	x	
		F	LATE DELIVERY RETURN CATERING	x	
		G	RETURN CATERING NOT LOADED AT PREVIOUS STATION	x	
		R	LATE CATERING DUE TO A/C CHANGE	x	
38	**ULD, lack of or serviceability**				
		A	LACK OF ULDs	x	
		B	UNSERVICEABLE OR DAMAGED ULDs	x	
		C	LATE PROVISION TO HANDLING UNIT	x	
39	**TECHNICAL EQUIPMENT, lack of or breakdown, lack of staff, e.g. push-back, GPU, ASU**				
		A	BREAKDOWN / LACK OF / LATE GPU	x	also used in case of FEGP (Fixed Electrical Ground Power Unit)
		B	BREAKDOWN / LACK OF / LATE DE-ICING EQUIPMENT		use 75D/E
		C	BREAKDOWN / LACK OF / LATE TOW BAR	x	

		D	BREAKDOWN / LACK OF / LATE AIRSTARTER	x	
		E	LATE/LACK OF AIR-CONDITIONER	x	
		F	LATE/LACK/BREAKDOWN OF PUSHBACK	x	
		G	LACK OF STAFF	x	
		H	LATE/LACK/BREAKDOWN OF OTHER TECHNICAL EQUIPMENT		Code itself
	TECHNICAL AND AIRCRAFT EQUIPMENT				
41	**AIRCRAFT DEFECTS during transit or after positioning on ramp**				
		A	TECHNICAL DEFECTS (NOT DAMAGES: 51 OR 52 OR ACARS SYSTEM: 58A)	x	
		B	CABIN OUTFIT MALFUNCTIONS (E.G. SEATS, GALLEY)	x	
		C	DEFECTS ON INFLIGHT ENTERTAINMENTS	x	
		D	AIRCRAFT LOADING SYSTEM FAILURE	x	
		E	AWAITING DEPARTURE DISPENSATION	x	
		R	MISSING TECHNICAL DOCUMENTS	x	
		S	OXYGEN REFILL	x	
		T	LACK OF STAFF	x	
42	**SCHEDULED MAINTENANCE, late release**				
		A	LATE DOCUMENTATION	x	
		B	LATE POSITIONING	x	
		C	LATE STAFF	x	
		D	VERSION CHANGE		use code 48 for LH
		E	DELAYS DURING TOWING OPERATION	x	
		F	LACK OF STAFF	x	
43	**NON-SCHEDULED MAINTENANCE, special checks and/or additional works beyond normal maintenance schedule**				

		A	LACK OF STAFF	x	
		B	LATE DOCUMENTATION	x	
		C	SPECIAL INSPECTIONS (E.G.AD'S)	x	e.g. lightning strike, heavy landing
44	**SPARES AND MAINTENANCE EQUIPMENT, lack of or breakdown**				
		A	LACK OF SPARES	x	
		B	LACK OF /BREAKDOWN OF MAINTENANCE EQUIPMENT	x	
		C	LATE DELIVERY OF SPARES	x	
		R	LACK OF LTL STAFF		
45	**AOG SPARES, to be carried to another station**				
		A	LATE DELIVERY TO AIRCRAFT	x	incorrect delivery as well
		B	LATE DOCUMENTATION	x	
		C	INCORRECT DOCUMENTATION	x	
		D	RELOAD OF AIRCRAFT	x	
		E	ADDITIONAL ENGINE POD	x	
		F	AOG FOR THIRD PARTY	x	
		R	LACK OF LOCAL TECHNICAL STAFF		non maintenance station and staff has to be sent from other location
46	**AIRCRAFT CHANGE, for technical reasons**				
		A	AIRCRAFT CHANGE AFTER DAMAGE BY OTHERS	x	e.g. KASKO
		B	AIRCRAFT CHANGE AFTER DAMAGE BY LIGHTNING ETC. (AS PER CODE 51)		use 51
		C	TECHNICAL CHECK COMPLIANCE	x	
		D	CONSEQUENTIAL - AFTER INITIAL A/C CHANGE ON ANOTHER SERVICE		use delay 96S
47	**STANDBY AIRCRAFT, lack of planned standby aircraft for technical reasons**				

48	**SCHEDULED CABIN CONFIGURATION/VERSION ADJUSTMENTS**				
		A	CABIN DIVIDER/ SEAT ADJUSTMENT	x	
		B	STRETCHER INSTALLATION	x	
		C	MEDICAL EQUIPMENT	x	incl. late or lack of Stretcher, PTC, Oxygen
		D	CREW REST SEATING	x	
		R	LACK OF OR LATE LCR		
49	**MAINTENANCE EQUIPMENT / FACILITIES / TOOLS (e.g.towing,jacking) lack of or break down**				
		R	APU INOP ENGINE START AT POSITION	x	
		S	LACK OF OR BREAKDOWN TOW TRUCK	x	if operated by LH TECHNIC
		T	LACK OF OXYGEN TRUCK	x	
		U	EDP BREAKDOWN OF LHT OR LTL EDP	x	
	DAMAGE TO AIRCRAFT				
51	**DAMAGE DURING FLIGHT OPERATIONS, bird or lightning strike, turbulence, heavy or overweight landing, collision during taxiing**				
		A	LIGHTNING STRIKE	x	
		B	BIRD STRIKE	x	
		C	OTHER DAMAGE DURING FLIGHT OPERATION		
		D	SEVERE WEATHER CONDITIONS	x	
		E	OVERWEIGHT/HEAVY LANDING	x	
		F	COLLISION DURING TAXIING	x	
		G	AIRCRAFT OVERRUN RUNWAY OR TAXI WAY	x	
		H	FOD DAMAGE	x	Foreign Object Damage / Compartment Contamination

		R	AIRCRAFT CHANGE AFTER DAMAGE BY LIGHTNING ETC. (AS PER CODE 51)	x	
52	**DAMAGE DURING GROUND OPERATIONS, collisions (other than during taxiing), loading/off-loading damage, contamination, towing, extreme weather conditions**				
		A	COLLISION (OTHER THAN DURING TAXIING), TOWING	x	
		B	CONTAMINATION, EXTREME WEATHER CONDITIONS	x	
		C	DAMAGE BY LOADING EQUIPMENT	x	
		D	DAMAGE BY AIR BRIDGE	x	
		E	DAMAGE BY STEPS	x	
		F	DAMAGE FUELING EQUIPMENT	x	
		G	DAMAGE BY TECHNICAL SUPPORT EQUIPMENT	x	
		H	DAMAGE BY CATERING EQUIPMENT	x	
		I	DAMAGE BY CLEANING EQUIPMENT	x	
		J	DAMAGE BY PUSHBACK EQUIPMENT	x	
		K	ACCIDENTAL ESCAPE SLIDE DEPLOYMENT	x	not caused by crew (68)
		R	MAINTENANCE AFTER KASKO DURING GROUND OPERATION	x	e.g. wheel change caused by nails etc. during taxiing
	EDP/AUTOMATED EQUIPMENT FAILURE				
55	**DEPARTURE CONTROL, check-in or weight & balance, host down**				
		A	LOCAL DCS EQUIPMENT FAILURE		use R-Y
		B	DCS HOST FAILURE	x	e.g. UNISYS HOST DOWN
		C	HOST NETWORK FAILURE	x	e.g. CUTE
		D	LOCAL NETWORK FAILURE	x	e.g. SITA

		E	SELF SERVICE DEVICE FAILURE	x	e.g. LCT
		R	STATION CONTROL SYSTEMS	x	e.g. BEST
		S	CHECK IN SYSTEM	x	
		T	OPS SYSTEM	x	e.g. WAB and Centralized Load Sheet
		U	AIRPORT SYSTEMS	x	e.g. , PSMP/Info 80-System Failure/BRS
		V	SECURITY SYSTEMS	x	e.g. GSS, BOARDING CONTROL
		W	BAGGAGE SYSTEM	x	e.g. WORLDTRACER,
		X	TICKETING/RESERVATION SYSTEMS	x	e.g. AMADEUS
		Y	COMMUNICATION BREAK DOWN	x	DAS, IGCC, ACARS
		Z	PICTURES	X	
56	**CARGO PREPARATION/DOCUMENTATION, host down**				
		A	LOCAL EQUIPMENT FAILURE	x	
		B	HOST FAILURE	x	
		C	HOST NETWORK FAILURE	x	
		D	LOCAL NETWORK FAILURE	x	
		E	AUTOMATED CUSTOMS CLEARANCE	x	
57	**FLIGHT PLANS, host down**				
		A	LOCAL EQUIPMENT FAILURE	x	e.g. LIDO
		B	HOST FAILURE	x	
		C	HOST NETWORK FAILURE	x	
		D	LOCAL NETWORK FAILURE	x	
		E	COMMUNICATION WITH ATC SYSTEM	x	
58	**OTHER AUTOMATED SYSTEMS**				
		R	PRINTER FAILURE	x	

	FLIGHT OPERATIONS AND CREWING				
61	**FLIGHT PLAN, late completion or change of, flight documentation**				
		A	CHANGE/AMEND OF FLIGHT PLAN	x	
		B	LATE FLIGHT DISPATCH DOCS	x	
		C	INCORRECT FLIGHT DISPATCH DOCS	x	
		D	LATE FILING OF ATC FLIGHT PLAN	x	
		E	INCORRECT FILING OF ATC FLIGHT PLAN	x	
		F	LATE FUEL OR PAYLOAD CHANGE DUE OPERATIONAL REQUIREMENT	x	
		G	LACK OF STAFF	x	
		H	FLIGHT BAG/ NAV KIT MISSING OR INCOMPLETE	x	
		R	LATE FLIGHT DOCUMENTATION DUE TO CHANGE OF SELF BRIEFING CREW STATUS	x	
62	**OPERATIONAL REQUIREMENTS, fuel, load, alteration**				
		A	FUEL ALTERATIONS	x	
		B	AWAITING FINAL WEIGHTS - FUEL CRITICAL FLIGHTS	x	
		C	LOAD ALTERATIONS	x	
63	**LATE CREW BOARDING OR DEPARTURE PROCEDURES, other than connection and standby (flight deck or entire crew)**				
		A	ENTIRE CREW LATE BOARDING	x	
		B	COCKPIT CREW LATE BOARDING	x	
		C	ENTIRE CREW LATE BOARDING DUE TO CREW BUS	x	
		D	COCKPIT CREW LATE BOARDING DUE TO CREW BUS	x	
		E	LATE CREW PICK UP (OTHER THAN CREW BUS)	x	

		F	GROUND TRANSPORTATION/AIRPORT ACCESS CONGESTION/CLOSURE	x	
		G	SECURITY PROCEDURES	x	
64	**FLIGHT DECK CREW SHORTAGE, sickness, awaiting standby, flight time limitations, crew meals, valid visa, health documents, etc.**				
		A	SICKNESS	x	
		B	AWAITING STAND BY CREW	x	
		C	FLIGHT TIME LIMITATIONS	x	
		D	TRAVEL DOCUMENTS	x	
		E	CREW SCHEDULING OR CREW CONTROL ERROR	x	
		F	LATE DUTY REPORT	x	
		G	INJURY OR DEATH	x	
		H	OPERATIONAL RATING INSUFFICIENT (E.G. CAT1 ETC.)		no more applicable for LH
		R	MANDATORY/MINIMUM CREW REST	x	
65	**FLIGHT DECK CREW SPECIAL REQUEST, not within operational requirements**				
		A	HOLDING/DELAYING PAX BOARDING BY CREW	x	
		B	REQUEST FOR MAINTENANCE NOT MINIMUM EQUIPMENT LIST	x	e.g. oxygen within limits
		C	LATE CATERING ORDER	x	CREW MEAL
		R	REQUEST FOR OTHERS NOT MINIMUM	x	
		S	CREW RELATIVES STANDBY PROBLEMS	x	
66	**LATE CABIN CREW BOARDING OR DEPARTURE PROCEDURES, other than connection and standby**				
		A	CABIN CREW LATE BOARDING	x	
		B	CABIN CREW LATE BOARDING DUE TO CREW BUS	x	
		C	LATE CREW PICK UP (OTHER THAN CREW BUS)	x	

		D	GROUND TRANSPORTATION/AIRPORT ACCESS CONGESTION/CLOSURE	x	
		E	SECURITY PROCEDURES	x	
67	**CABIN CREW SHORTAGE, sickness, awaiting standby, flight time limitations, crew meals, valid visa, health documents, etc.**				
		A	SICKNESS	x	
		B	AWAITING STAND BY CREW	x	
		C	FLIGHT TIME LIMITATIONS	x	
		D	TRAVEL DOCUMENTS	x	
		E	CREW SCHEDULING OR CREW CONTROL ERROR	x	
		F	LATE DUTY REPORT	x	
		G	INJURY OR DEATH	x	
		R	MANDATORY/MINIMUM CREW REST	x	
68	**CABIN CREW ERROR OR SPECIAL REQUEST, not within operational requirements**				
		A	INCORRECT HEAD COUNT	x	
		B	RE-ORDER OR LATE REQUEST - CATERING		not applicable
		C	RE-ORDER OR LATE REQUEST - TOILET SERVICE	x	Water fill up
		D	RE-ORDER OR LATE REQUEST - CLEANING	x	
		E	EVACUATION SLIDE DEPLOYED	x	
		F	HOLDING/DELAYING PAX BOARDING BY CREW	x	
		R	GALLEY/MEAL CHECK	x	
		S	CABIN CREW REQ ADDITIONAL CATERING (FOR PAX)	x	not standard meals / equipment
		T	LATE ORDER OF NON STANDARD SUPPLIES (E.G. BLANKETS, HEADPHONES, SARS KIT ETC.)	x	LH CABIN CREW PROCEDURE
		U	LATE ORDER CREW MEAL	x	

69	**CAPTAIN REQUEST FOR SECURITY CHECK, extraordinary**				
	WEATHER				
71	**DEPARTURE STATION**				
		A	OUTSIDE AIRCRAFT LIMITS	x	
		B	OUTSIDE CREW LIMITS		check if still applicable
		R	WEATHER BELOW OPERATING LIMITS	x	
72	**DESTINATION STATION**				
		A	OUTSIDE AIRCRAFT LIMITS	x	
		B	OUTSIDE CREW LIMITS		check if still applicable
		R	WEATHER BELOW OPERATING LIMITS	x	
73	**EN ROUTE OR ALTERNATE**				
		A	OUTSIDE AIRCRAFT LIMITS	x	
		B	OUTSIDE CREW LIMITS		check if still applicable
		C	ETOPS	x	alternate closed due to weather
		R	WEATHER BELOW OPERATING LIMITS	x	
75	**DE-ICING OF AIRCRAFT, removal of ice and/or snow, frost prevention excluding unserviceability of equipment**				
		A	REMOTE DE-ICING	x	
		B	DE-ICING ON POSITION	x	
		C	ADDITIONAL DE-ICING AFTER HOLDOVER TIME EXPIRED	x	
		D	LACK OF EQUIPMENT	x	
		E	BREAKDOWN OF EQUIPMENT	x	
		F	LACK OF STAFF	x	

		G	LACK OF FLUID	x	
76	**REMOVAL OF SNOW, ICE, WATER AND SAND FROM AIRPORT**				
		A	AIRPORT CLOSURE DUE TO HEAVY WEATHER CONDITIONS	x	as well as runway
		B	LACK OF POSITIONS DUE TO WEATHER CONDITIONS	x	
		C	REMOVAL OF SNOW/ICE/WATER/SAND FROM AIRPORT	x	incl. jetways and stairs
77	**GROUND HANDLING IMPAIRED BY ADVERSE WEATHER CONDITIONS**				
		A	INTERRUPTION OF FUELLING OR SERVICING	x	
		B	APRON CONDITIONS	x	
		C	HIGH WINDS - DOOR OPERATION LIMITS	x	
	AIR TRAFFIC FLOW MANAGEMENT RESTRICTIONS				
81	**ATFM DUE TO ATC EN-ROUTE DEMAND/CAPACITY, standard demand/capacity problems**				
		R	INDUSTRIAL ACTION	x	
		S	EQUIPMENT FAILURE	x	
		T	STAFF SHORTAGE	x	
		U	HIGH DEMAND OR CAPACITY	x	
82	**ATFM DUE TO ATC STAFF/EQUIPMENT EN-ROUTE, reduced capacity caused by industrial action or staff shortage or equipment failure, extraordinary demand due to capacity reduction in neighbouring area**				
		R	INDUSTRIAL ACTION	x	
		S	EQUIPMENT FAILURE	x	
		T	STAFF SHORTAGE	x	
		U	HIGH DEMAND OR CAPACITY	x	

83	**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**				
		R	INDUSTRIAL ACTION	x	
		S	EQUIPMENT FAILURE	x	
		T	STAFF SHORTAGE	x	
		U	RUNWAY CLOSED	x	
		V	NOISE ABATEMENT/NIGHT CURFEW	x	
		W	POLITICAL UNREST	x	
		X	HIGH DEMAND OR CAPACITY	x	
84	**ATFM DUE TO WEATHER AT DESTINATION**				
	AIRPORT AND GOVERNMENTAL AUTHORITIES				
85	**MANDATORY SECURITY**				
		A	CONGESTION AT SECURITY CHECK	x	
		B	BAGGAGE IDENTIFICATION / UNLOADING DUE TO MISSING PAX	x	
		C	SPECIAL AIRPORT SECURITY/ABANDONED ARTICLES	x	unattended baggage
		D	BOMB WARNING	x	
		E	DECLARED SECURITY BREACH	x	security risk: passenger left gate area uncontrolled
		F	ADDITIONAL/SPECIAL SECURITY INSPECTIONS	x	searching of A/C by specialists
		G	MANDATORY PAX OFFLOAD	x	with baggage
		H	LACK OF STAFF	x	
		I	BREAKDOWN OF EQUIPMENT	x	

		R	SPECIAL SECURITY CHECK INVOLVING PAX, BAG AND HANDBAGGAGE AT THE AIRPORT SIDE	x	e.g special US regulations
		S	ADDITIONAL AVI CHECK	x	
		T	INTENDED OFFLOAD DUE TO MISSING PAX	x	"red bags"
86	**IMMIGRATION CUSTOMS, HEALTH disinfection of aircraft**				
		A	IMMIGRATION / CUSTOMS INFRASTRUCTURE	x	
		B	LACK OF STAFF	x	
		C	HEALTH	x	e.g. SARS checks
		D	INSUFFICIENT TRAVEL DOC OF PAX / INAD / DEPORTEE	x	e.g. false passports
		E	INCOMING PASSENGER CHECKS	x	
		F	AIRCRAFT DISINFECTION	x	
		G	AIRCRAFT SEIZURE		
		H	QUARANTINE	x	
		R	ADDITIONAL BAGGAGE CHECK ON OFFICIAL REQUEST	x	
		S	CUSTOMS CHECK INBOUND BAGGAGE LH.....	x	transfer baggage
		T	LATE DEPORTEE BOARDING	x	
87	**AIRPORT FACILITIES, parking stands, ramp congestion, lighting, buildings, gate limitations, etc.**				
		A	LACK OF PARKING STANDS	x	or blocked non LH positions
		B	LIGHTING OR BUILDINGS	x	
		C	BAGGAGE SORTING SYSTEM DOWN / SLOW		LH use code 18
		D	NO PUSH BACK CLEARANCE DUE TO INFRASTRUCTURE	x	taxi way limitations, P/B incl. Registration
		E	JET BRIDGE INOPERATIVE	x	
		F	GATE LIMITATION / NO GATE AVAILABLE	x	or blocked
		G	LACK OF CHECK IN COUNTERS	x	
		H	RAMP CONGESTION	x	
		I	ELECTRICAL SYSTEM FAILURE	x	AS WELL EDP

		J	PASSENGER TRANSPORT SYSTEM FAILURE	x	e.g. sky train
		K	PUBLIC ADDRESS/FLIGHT INFORMATION DISPLAY SYSTEM FAILURE		LH use 55
		L	INSUFFICIENT FIRE COVER	x	
		M	GROUND COMMUNICATION SYSTEM FAILURE	x	e.g. telecommunication
		R	NO PUSH BACK CLEARANCE DUE TO CONSTRUCTION	x	
		S	BREAKDOWN OF AIRPORT FUELING SYSTEM	x	
		T	LATE OR LACK OF FOLLOW ME FOR PUSH-BACK	x	
88	**RESTRICTIONS AT AIRPORT OF DESTINATION, airport and/or runway closed due to obstruction, industrial action, political unrest, noise abatement, night curfew, special flights (excluding weather)**				
		A	RESTRICTIONS DUE TO CURFEW	x	DELIBERATE HOLD DUE TO SHORT FLIGHT TIME (CURFEW AT DESTINATION A/P)
		B	INDUSTRIAL ACTION	x	
		C	POLITICAL UNREST	x	
		D	AIRPORT CLOSURE	x	
		E	RUNWAY CLOSURE	x	
		R	CONSTRUCTION WORK/MAINTENANCE	x	e.g. Landing Restriction due to local requirements
89	**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 weather (restriction due to weather in case of AFTM regulation only, else refer to code 71 (WO)), industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights**				

		A	RESTRICTIONS DUE TO CURFEW	x	
		B	INDUSTRIAL ACTION	x	
		C	POLITICAL UNREST	x	
		D	AFTM REGULATIONS	x	
		E	AIRPORT CLOSURE	x	
		F	RUNWAY CLOSURE	x	
		R	BREAKDOWN AFTM/ATC COMPUTER	x	
		S	LOST FLIGHT PLAN BY ATC	x	
		T	CONSTRUCTION WORK/MAINTENANCE	x	
	REACTIONARY				
91	**LOAD CONNECTION, awaiting load from another flight**				DISTINGUISH PAX, BAG, CARGO/MAIL, LIFE AND DEATH
		R	PAX AND/OR BAGGAGE (+ FLT.-NR.)	x	
		S	PAX AND/OR BAGGAGE (+ FLT.-NR.) OAL	x	
		T	CARGO AND MAIL (+ FLT.- NR.)	x	
		U	SHORT CONNEX / RDS	x	
92	**THROUGH CHECK IN ERROR, passenger and baggage**				
		A	NO THROUGH CHECK IN / INCORRECT TRANSIT / TRANSFER FIGURES PAX AND BAGGAGE	x	
		B	MISSING/INCORRECT SEPARATION OF TRANSIT / TRANSFER / LOCAL LOADS	x	
		R	THROUGH CHECK IN ERROR, PASSENGER AND/OR BAGGAGE (+ STATION OF ORIGIN)	x	caused by previous station(s)
		S	THROUGH CHECK IN ERROR, PASSENGER AND/OR BAGGAGE (+ STATION OF ORIGIN) SPECIAL HANDLING	x	caused by previous station(s)

		T	THROUGH CHECK IN ERROR, PASSENGER AND BAGGAGE (+ STATION OF ORIGIN) DOCS INCL. OFFLOAD OF BAG	x	caused by previous station(s) docs checks not correct
		U	THROUGH CHECK IN ERROR, PASSENGER AND BAGGAGE (+ STATION OF ORIGIN) CARRY-ON BAGGAGE (DOCUMENTATION OF STATION OF ORIGIN)	x	oversize / numbers of pieces hand baggage
93	**AIRCRAFT ROTATION, late arrival of aircraft from another flight or previous sector**				
		A	LATE ARRIVAL DUE DEPARTURE DELAY AT PREVIOUS STATION	x	
		B	LATE ARRIVAL DUE ENROUTE DELAY	x	
		C	LATE ARRIVAL DUE DELAY AFTER LANDING	x	e.g. long taxi time
94	**CABIN CREW ROTATION, awaiting cabin crew from another flight (including deadheading cabin crew members)**				
		A	OPERATING CREW	x	
		B	POSITIONING OR DEADHEAD CREW	x	
95	**CREW ROTATION, awaiting flight deck or entire crew from another flight (including deadheading crew members)**				
		A	OPERATING CREW	x	
		B	POSITIONING OR DEADHEAD CREW	x	
96	**OPERATIONS CONTROL, rerouting, diversion, consolidation, aircraft change for reasons other than technical**				
		A	REROUTING	x	
		B	CONSOLIDATION	x	delay of flight to accommodate pax of a later flight
		C	AIRCRAFT CHANGE/EQUIPMENT CHANGE FOR REASONS OTHER THAN TECHNICAL	x	
		D	DIVERSION	x	

		E	RESCHEDULED GROUND TIME LESS THAN DECLARED MIN GROUND TIME	x	e.g. due to ACH insufficient GT
		F	LATE DISPATCH RELEASE	x	due to rerouting
		G	CONTROLLER/PLANNER ERROR	x	
		H	OCC DISRUPTION	x	e.g. lack of staff, break down of OPS control system
		R	DEFUELLING DUE TO OPS REASON		e.g. ACH/ECH
		S	SECONDARY TECHNICAL REASON		First Change is code 46 and delay 96S has to be used for all changes on the same day (long haul incl. previous day) also in case of lack off spares + AC change caused by another station
	MISCELLANEOUS				
97	**INDUSTRIAL ACTION WITH OWN AIRLINE**				
		A	LOCAL STATION	x	
		B	WHOLE COMPANY	x	
		C	PASSENGER HANDLING	x	
		D	RAMP HANDLING	x	
		E	CARGO	x	
		F	CATERING	x	
		G	FLIGHT DECK CREW	x	
		H	CABIN CREW	x	
		I	TECHNICAL	x	
		J	IT / SUPPORT	x	
		K	FUEL	x	
		L	OTHER OPERATIONAL	x	

98	**INDUSTRIAL ACTION OUTSIDE OWN AIRLINE, excluding ATS**				
		A	NATIONAL STRIKE	x	
		B	WHOLE HANDLING COMPANY	x	
		C	PASSENGER HANDLING	x	
		D	RAMP HANDLING	x	
		E	CARGO	x	
		F	CATERING	x	
		G	TECHNICAL	x	
		H	CLEANING	x	
		I	IT / SUPPORT	x	
		J	FUEL	x	
		K	OTHER OPERATIONAL	x	
		L	SECURITY	x	
		M	FIRE BRIGADE	x	
		N	AUTHORITIES	x	
		O	AIRPORT	x	
99	**This code shall be used only when it is clear that a reason cannot be matched to a code above (explain in SI section)**				

Appendix III

Codebook to the questionnaire used during the survey

Variable	Label	Values	Missing/ Non – plausible values*
A01	Position	1: FM 2: AFM 3: SL SO	99
A02	Duration of employment at LH	1: shorter than 3 years 2: 3 to 8 years 3: 9 to 14 years 4: 15 to 24 years 5: longer than 25 years	99
A03	In the specific position since	1: shorter than 3 years 2: 3 to 8 years 3: 9 to 14 years 4: 15 to 24 years 5: longer than 25 years	99
A04	Gender	1: Male 2: Female	99
B01	Are you notified about the current status and the changes of the outbound punctuality quality on a regular basis?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
B02	Do you discuss punctuality issues with your colleagues regularly?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
B03	Do you discuss punctuality issues with your superiors regularly?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
B04	Are you notified about newly introduced punctuality measures regularly?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
B05	Are employees trained for outbound punctuality on a regular basis?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
B06	Do you get feedback about punctuality relevant incidents?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99

C01	Do you think that the current organization of the processes at the hub FRA is likely to have a positive influence on the outbound punctuality performance?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
C02	In your opinion did the introduction of a central hub control system have any influence on your personal work pressure?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
C03	***If not, why in your opinion?***	***Precoded (see following variables)***	
C03A	Workload has not changed	1: mentioned 2: not mentioned	99
C03B	Lack of communication HCC <-> Shop floor	1: mentioned 2: not mentioned	99
C03C	Too focused on own work	1: mentioned 2: not mentioned	99
C03D	HCC to far away and anonymous	1: mentioned 2: not mentioned	99
C03E	Too many people involved	1: mentioned 2: not mentioned	99
C03F	Others	1: mentioned 2: not mentioned	99
C04	Would you describe your cooperation with the central hub control as likely to have a positive influence on the overall outbound punctuality performance?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
C05	Do you see an urgent call for action in this field?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
D01	Do you contribute to the process of punctuality improvements with own ideas regularly?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
D02	Were any of your ideas introduced?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
D03	Were you notified about the decisions concerned with your idea?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99

D04	Is outbound punctuality rewarded by your superiors?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
D05	Are measures taken when punctuality rules are violated?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
D06	Would you describe your current state of motivation towards punctuality as positive?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
D07	In your opinion does your personal work have any influence on the outbound punctuality performance at all?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
D08	Please estimate the potential improvement of punctuality within your spheres of action. (in %)	Percentage	99
E01	Who in your opinion is the major responsible for punctuality issues at the hub FRA?	1: Hub Manager 2: Station Manager 3: Punctuality Manager 4: Somebody else	99
E02	What is the name of the punctuality manager?	1: right (Krestan) 2: wrong (not Krestan)	99
E03	Do you know about the tasks of this person closer?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
E04	Do you contact this person concerning punctuality relevant issues on a regular basis?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
E05	Did you get the assistance/ feedback you expected?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
E06	Do you think the work of this person is important?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99

E07	In your opinion has the work of this person had any positive influence on the punctuality performance yet?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
F01A	Most frequent delaycode	Delaycode	99
F01B	Second most frequent delaycode	Delaycode	99
F01C	Third most frequent delaycode	Delaycode	99
F02	***What is the most frequent reason for delays at Frankfurt Airport?***	***Precoded (see following variables)***	
F02A	Weather	1: mentioned 2: not mentioned	99
F02B	A/C Rotation	1: mentioned 2: not mentioned	99
F02C	Crew Rotation	1: mentioned 2: not mentioned	99
F02D	Offload luggage	1: mentioned 2: not mentioned	99
F02E	ATC/ Slot	1: mentioned 2: not mentioned	99
F02F	Airport Facilities/ Infrastructure	1: mentioned 2: not mentioned	99
F02G	Late PAX at Gate	1: mentioned 2: not mentioned	99
F02H	A/C Handling (Ramp)	1: mentioned 2: not mentioned	99
F02I	Security	1: mentioned 2: not mentioned	99
F02J	GSS	1: mentioned 2: not mentioned	99
F02K	Short ground time A/C	1: mentioned 2: not mentioned	99
F02L	Short connex time PAX	1: mentioned 2: not mentioned	99
F02M	Lack of staff	1: mentioned 2. not mentioned	99
F02N	Late inbounds	1: mentioned 2: not mentioned	99
F03	Do the delay statistics reflect the actual reasons for delays in an appropriate way?	1: Yes 2: Rather Yes 3: So So 4: Rather No 5: No	99
F04	Do you think that the allocation of delay codes is transparent and easily	1: Yes 2: Rather Yes 3: So So	99

	understandable?	4: Rather No 5: No	
F05	***If not, where do you see problems?***	***Precoded (see following variables)***	
F05A	Communication HCC <-> Shop floor	1: mentioned 2: not mentioned	99
F05B	Everybody tries to put the blame onto someone else	1: mentioned 2: not mentioned	99
F05C	Glossing over the facts of the delays – true reasons ought to be covered up	1: mentioned 2: not mentioned	99
F05D	Fraport Loadmaster responsible for delay code allocation – often not transparent for the shop floor	1: mentioned 2: not mentioned	99
F05E	SE/O allocates delay codes often without contacting the shop floor	1: mentioned 2: not mentioned	99
G01	Place for your comments - Please feel free to write whatever you wanted to say about the outbound punctuality at Frankfurt	Not SPSS based (see separate document)	

*The following answers are put under Missing/ Non-plausible Values:

- Missing answers
- all multiple answers in single answer questions
- all answers that point out that a possible misunderstanding of the question is obvious