Flight Crew Bidding and Rostering in Major European Airlines

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Abstract

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This thesis studies the practises on flight crew bidding and rostering in major European airlines. Answers are to be found how pilots are allowed to state their preferences, how objectives for preference satisfaction have been set and how transparency and predictability is solved.

Flight crew is one of the most important resources for airlines and ensuring proper manning of every flight is vital part of crew management systems. Requirements for rostering are coming from different regulations, collective labour agreements and company-based efficiency targets. Additionally, crew rostering has effect on job satisfaction and due to flight crew critical role for the airline this area should be well managed.

The knowledge base introduces reader to the rather complex operational environment of flight crew planning and how airline business model, base structure and location, and network play role in rostering. Crew rostering and planning process is described in detail and how the process must observe different objectives coming from fatigue management, flight crew preferences, legislation and handled both when building flight pairings and individual monthly rosters.

Rosters are one part of employment relationship and high quality of the employment relationship predicts higher level of service quality, better labour, and aircraft productivity, not to mention effect on operating margins. This aspect is important especially now when many airlines are facing challenges to attract new pilots to join and ensure already employed pilots to stay. Proper and satisfactory roster practises is one factor in pilot job satisfaction, declined during Covid19.

Research was made using a mixed method and 28 European airlines are represented in results. The questionary was shared among European Cockpit Association member associations representing over 40 000 professional pilots.

According to the findings the rostering practises differ hugely among airlines and there is not any industry standard available. There are even differences under same airline groups and airline consolidations or alliances do not mean unified approach to rostering. Pilots are offered different ways to state their preferences and those looking for improvements in their airline could find new repair tools from this study and improve pilots job satisfaction by developing new ways to meet the needs of private life.

Clear need for improvements is to be found around communications, clear and predictable rules and offering flexibility for the pilots to state their preferences according to their needs. Surprising high number of airlines are not analysing pilots´ satisfaction to the rostering and seems to leave one really important area related to shift working undeveloped.

Key words
Flight crew, bidding, rostering, preferences

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1 Introduction

Aviation business is a complex network of multiple layers with constantly changing operational environment. The industry connects people and service providers, transports people and goods in global networks around the clock and is one of the most important transportation means. The aviation industries advantage is the speed of the transportation, but also ability to allocate new capacity fast to those areas with increasing demand.

As the ability to change network and resource allocation is the main advantage of aviation, this requires the whole planning system to enable the re-allocation of the main assets: aircraft and crew. Airlines´ biggest investment is aircraft and the business is capital intensive. The goal of every airline is to use aircraft as much and as efficient possible, measured by block hours on daily basis. Higher the daily block hours per aircraft, more efficient use of capital is reported. Airlines have several other areas to plan as well. Without marketing planning no tickets would be sold, without maintenance planning aircraft airworthiness would not be kept and list would go on for several other topics.

This thesis concentrates on flight crew resource planning, roster arrangements and pilots´ possibilities to influence to the planning. The background of this study is the author´s background as a commercial pilot and long history of pilot representation in the union. Finnish Pilots´ Association, professional association representing all commercial pilots in Finland, cooperated with Leicester University PhD research on pilot job satisfaction pre- and after Covid 19 (Vulturius 2023.). This research has brought in light the declined job satisfaction and areas where improvement in work related areas could be beneficial. One of these areas was airline roster practises and this thesis aims to identify available tools for the roster development.

Pilots are highly dependable on their roster structure, trying to influence their monthly flight duty days allocation and enable social life while flying aircraft in global networks night and day. Pilot´s ability to state preferences for flying (time, date, destinations) and possibility to foresee next roster days off have been argued for decades. Same applies for roster publishment dates as without official, published roster the pilot really does not have any visibility for coming weeks or months.

For the employer, roster planning is both resource planning in efficient ways, but also keeping their pilots satisfied. Without satisfied pilots, the overall commitment to ensure reliable operations safe and on time would decline. Without proper planning pilot fatigue would increase threating the overall safety or increasing days of absence and sick leaves.

1.1 Research question and purpose

Flight crew resourcing and rostering is about ensuring enough pilots available for planned network, aircraft, and flight schedules. This is quite complex environment with requirements from several authorities, national legislation, and collective labour agreement (CLA). The roster planning can be observed from two point of views, from the airline (employer) and pilots (employee), both having their expectation what is a proper planning result.

The aim of this study is to collect data from European major airlines how flight crew bidding has been organized and how rosters are published on monthly basis. Rostering practises are not standardized in Europe, although some guidance is offered by European Aviation Safety Agency (EASA). Rostering varies as airlines operate different routes, different aircraft and business models are adapted to local environment.

With the results, this study can present different options to be reconsidered by both parties, airlines, and pilot associations to improve roster planning.

Research questions are:

- How pilots are enabled to state their preferences for roster planning
- How the objectives of preference satisfaction have been set
- How transparency and predictability in roster publishment has been solved

Research questions	**Theoretical framework (chapter)**	**Results (chapter)**	**Questionary (questions)**
How pilots are enabled to state their preferences for roster planning	3 5.4	7.2	7-10
How the objectives of preference satisfaction have been set	3 5.2., 5.3., 5.4.	7.3	11-12
How transparency and predictability in roster publishment has been solved	3.2. 4.6	7.4	13-15

1.2 Scope of the study

Data collection is limited to European major airlines and flight crew (pilots) roster practises. As the final product is intended to help traditional airline and pilot association concentrating on intercontinental and continental traffic, business jet operators and all-cargo airlines are left outside the survey.

This study is not going to suggest the best option for roster planning as this is matter of negotiations and is also dependable of planning software capabilities and negotiating parties´ own judgement.

1.3 Thesis structure

This thesis introduces first the reader to the basic concepts in airline resource planning and rules and regulations affecting the flight crew pairing and rostering arrangements. Second, this study offers view to pilots' job satisfaction and how rosters play essential role in it and introduces different bidding systems.

Scheduling as a process is described in separate section with more detailed information provided from pairing and rostering phases. Finally, results from the survey are presented with conclusions and recommendations for further studies.

2 Operational environment in flight crew planning

In this section a brief prescription is given about operational environment related to crew planning. Resource planning in airline business is at the same time similar process, but every airline has unique features due to size, geographic location, business model and applicable legislation.

2.1 Different airlines

Airlines can be defined from various points depending on context. Type of operations, fleet structure, cost base (low cost or full-service carrier) and business models affect also to airline resource planning. When the airline network is the observation point, airlines´ services can be categorized according to intercontinental, continental, regional or domestic (Abdelghany & Abdelghany 2016, 2.). Further, airlines may operate on business model that offers customers only point to point flights, but the concept may be completely different setup when observing operations and resource allocation by aircraft and crew rotations.

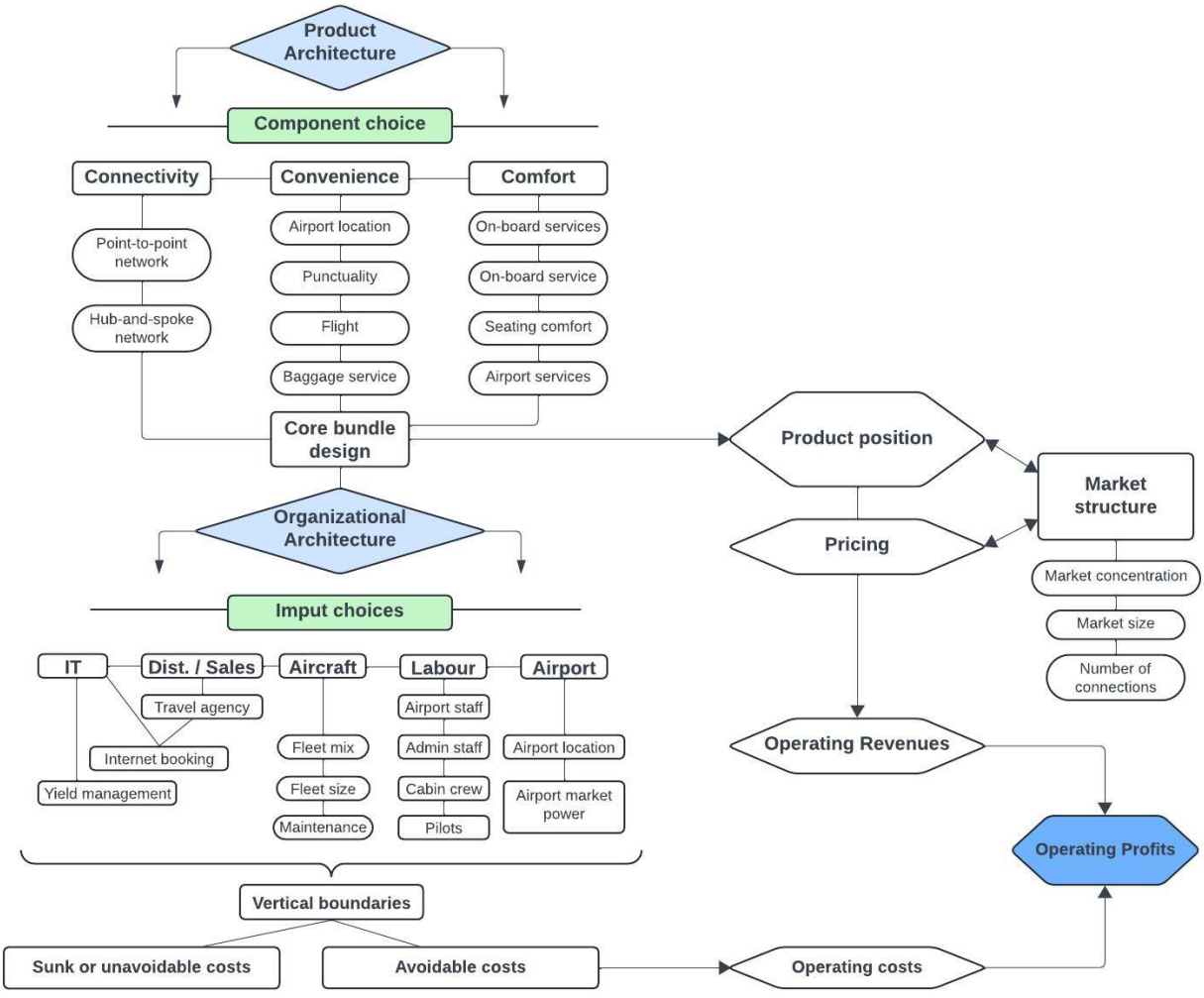

Figure 1 Product and organizational architecture of airlines (adapted from Mason and Morrison 2008, 76.)

Mason & Morrison (2008, 75.) studied due to lack of consistent and standardized model of airline categories apply product and organizational architecture (POA) for this purpose. The POA model highlighted the importance of the network and connectivity when observing the airlines operating model and the realities while using resources efficiently. POA model offers also good view of the complex environment and how organization structure and different decisions affect to resource planning (Figure 1).

Magdalina & Bouzaima found in their investigation of European airline business models (2021, 7.) that distinction between different business models, especially between full-service carriers (FSC) and low-cost carriers (LCC) is nowadays less clear. Their study was able to identify among 49 European airlines´ business models four different classes with FSC and LCC on opposite ends, but in between two hybrid business models (Hybrid 1 and Hybrid 2) depending on, for example flight frequencies, aircraft fleet structures (narrow and wide body aircraft) and travel class offerings.

Traditionally when observing resource planning the business segment plays important role. Airline may be concentrating to air cargo operations, wet lease operations (ad hoc), leisure flights or business jet operations. These all have their unique operational environments that offer both more opportunities and requirements for crew planning. For example, business jet operations offer great flexibility for customers and many flights are ad hoc based requiring more standby crews. Leisure and wet lease operation providers operate from multiple airports and requires more dead head flights for crews while operating outside home base.

2.1.1 Network carriers

For network structure, so called hub and spoke concept means a network of flight routes formed around major airports and connects regularly smaller airports (Andersson, Housos, Kohl, Wedelin 1998, 231.). Many airlines build extensive flight service networks around hubs and try to offer their customers multiple options to reach their destination globally.

As the code sharing is normality especially among traditional carriers, the overall picture on resource planning might be challenging to understand. Regional traffic may be built with partners, partly or wholly wet leased or with mutual benefit combining two independent operators. Same applies to wider continental and intercontinental flying where especially flights between mega hubs may be flown by different joint venture models under same airline alliance.

2.1.2 Multi-hub operations

Landscape and legislation also affect airline resource planning. In United States, the biggest single aviation market area, airline consolidations have gained the high level and top 3 airlines hold 50% of all scheduled seat capacity in the region (IATA 2023.). To reach this kind of market share in United States, big airlines must have multiple hubs and for resource planning this means also multiple home bases for crews. Crew members may work under same employer from multiple hubs and resources can be used in wide network in multiple ways as some aircraft types may be flying from certain hubs only.

In Europe, the consolidation is running behind the USA markets due to legislation or cultural reasons and to reach 50% seat capacity, it takes 10 carriers combined numbers. In Europe most of the traditional airlines have organized their operations mainly around 1-2 hubs (geographically bigger countries may have two hubs like in Germany Frankfurt and Munich, in Spain Madrid and Barcelona) and flights normally are return flights to and from main hub from aircraft point of view (IATA 2023.).

Especially low-cost carriers (EasyJet, Ryanair, Wizzair) operate with multiple home bases in Europe. Same applies for airline groups that may include several own brands like Lufthansa group (Lufthansa, Swiss, Eurowings, Austrian). European airline groups are mainly operating their aircraft under independent brands and air operator certificates (AOC) and crews can´t be transferred between different AOCs of same airline group (crew flying first day under Lufthansa and next day under Austrian). EASA regulative change of interoperability can change this in Europe in the future and open new needs for legislation to secure even playfield (ECA, 2018.).

2.2 Aviation authorities

Aviation is highly regulated business environment, but due to sovereign states, national laws apply unless otherwise agreed. Many parts of the aviation legislation regarding flight safety are agreed on global level with the help of International Civil Aviation Organization (ICAO). ICAO is United Nations agency with 193 countries cooperating on the fields of flight safety, technical development, connectivity, and sustainable growth (ICAO, 2024.).

As ICAO is not able to force agreed rules and regulations to be followed, it is up to member states to ratify those rules to national legislation or at least state clearly what parts of those recommendations are not followed. Regarding guidance related to crew planning, ICAO guidance is referring to fatigue management and these suggested practises are implemented to several ICAO Annexes and Standards and Recommended Practises (SARPs).

For regional aviation authorities, two most capable aviation safety authorities are European Union Aviation Safety Agency (EASA, Europe) and Federal Aviation Agency (FAA, United States). In Europe EASA prepares legal framework and these regulations are approved depending on the context either via European Commission and Parliament or by EASA itself. National aviation authorities are mandated to oversee airlines and how they follow and meet the guidance of common rules and regulations (European Union, 2024.).

In Europe EASA enhance regulations that require all participants to follow them. Due to fact that the aviation landscape is complex environment and airlines with their operational needs are different, some of the regulations offer some room for local adjustments. EASA has three main levels of Regulatory material as follows (EASA, 2024):

- Basic regulation (European Parliament and European council)
- Implementing rules to the Basic Regulation, given by European Commission
- Certification specifications, Acceptable Means of Compliance (AMC) and Guidance Material, given by EASA

EASA publishes non-binding guidance to regulations as Acceptable Means of Compliance where more detailed information is provided for the stakeholders how to follow regulations and how national authorities should oversee different practises. If the regulation and Acceptable Means of Compliance is not ideal for the specific airline, they may apply process according to Alternative Means of Compliance (AltMoC) model and demonstrate how their alternative mean is meeting the regulatory goal. These AltMoC approvals by national (competent) authorities must be notified to EASA and list of approvals are published (EASA 2024).

2.3 Fatigue

As the aviation is a global industry and transportation of people and goods use intercontinental networks, working hours during night-time and long duty times cannot be avoided. Fatigue is present in some form both in ground operations (handling, operation centers) and in air operations where crew must cope with different time zones both during duty and rest periods.

Fatigue has been identified one of the threats for flight safety as fatigue decreases human performance. Due to aviation´s role connecting people and transporting goods globally around the clock, flight crew faces working hours during challenging times for the human body (ICAO 2012, 18.). Further, fatigue has been scientifically proven to have a significant effect to performance. Overall performance decreases especially in monotonous tasks and task-related inputs (Williamson et al. 2011, 594.).

By ICAO SARP´s, states are required to develop regulations related to flight times, duty, and rest periods so that fatigue would not accumulate, and crew members would remain sufficiently alert during operations. To manage the threat to flight safety, operators are required to involve fatigue one of the topics in their Safety Management System (IATA, ICAO & IFALPA 2015, 56.). Management of fatigue is taken care for example, by planning the schedules so that State regulations regarding duty limitations are not exceeded.

2.3.1 Fatigue Risk Management System (FRMS)

On top of the basic flight time regulations, ICAO SARPs acknowledge the need due to network structure and commercial reasons to offer some level flexibility for the operators for operations that is known to create fatigue (IATA 2024.). Operators are in this case required to establish Fatigue Risk Management System (FRMS) and these systems are tailored for operator's specific environment. As the European safety regulator, EASA has followed the ICAO SARPs and fatigue risk management is introduced to regulations regarding operators´ certification specifications.

For crew planning fatigue is one of the aspects to be observed and modern crew planning software is capable to support planners while pairings and schedules are planned. In proper scheduling different factors causing factor can be considered and mitigations (rest) planned so that crew performance capabilities may be secured (Figure 2.).

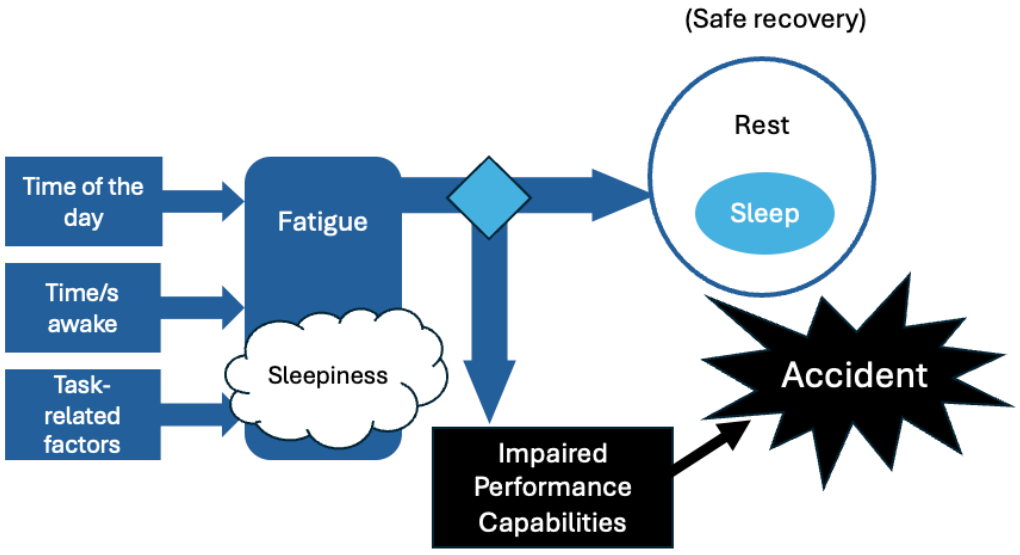

Figure 2. Relationship between fatigue and safety (Adapted from Williamson et al. 2011)

Airlines are encouraged to intergrade FRMS to their operations and evaluate defensive strategies to manage fatigue-related risks in aviation. Responsibility is also given for individual pilots so that adequate rest is ensured prior reporting to the duty (ICAO 2012, 19.). Safety culture also requires

procedures and encouragement for the crew members to report fatigue during the actual operations and not to report to the duty if they are not adequately rested (IATA, ICAO & IFALPA 2015, 61.).

It is important to understand that “the perfect schedule for the human body is daytime duties with unrestricted sleep at night. Anything else is a compromise” (IATA, ICAO, IFALPA 2015, 61.) and by working against of human body circadian body clock mitigations must be introduced so that fatigue is manageable. At the same time all crew members are individuals and their capabilities to rest are unique.

2.3.2 Biomathematical models of human fatigue

As the understanding of human performance and fatigue has increased, specialized biomathematical models and software have been developed for the crew scheduling. These models are based on previous studies on human performance, circadian and sleep/wake processes and how these could be managed in shift working. Mallis, Mejdal, Nguyen & Dinges (2004, 11.) studied seven biomathematical models and found that the inputs to the calculations play role. Some models treat for example, off-duty wake time as rest time and others comparable to work time. There seems to be also different approach in models how effects in environmental variations are estimated.

Jeppesen crew management system offers Boeing Alertness Model (BAM) as one solution to evaluate crew fatigue as part of the planning process. This model can be used supporting the roster planning and unscheduled changes in operations by the airline itself and additionally individual users can download the CrewAlert -application (Jeppesen 2024.).

Australian Civil Aviation Safety Authority (2014, 11.) highlights that even when biomathematical fatigue models are based on academic studies, models do have their limitations and alertness models should not be used as a sole means for decision making in operations.

EasyJet and NASA cooperation evaluated airline rostering practises and how variable roster could be improved to ensure flight safety. Study confirmed the importance of pilots´ understanding of human performance and findings suggested that adequate fatigue training is ensured. At the same time, it was noticed that pilots sleep less before early morning shifts and humans are more capable to extend their sleep than start the rest earlier (Srivastava & Barton 2012, 6. & 91.).

2.4 Cost and resource optimization

Airline operations requires various resources to be handled and primal resources are airplanes, staff, ground infrastructures and finally fuel. From overall operational costs fuel represents normally

the biggest share followed by personnel costs (30%). For this reason, airlines are keen to follow personnel scheduling policies and optimize their use for the best outcome (Maenhout & Vanhoucke 2011, 194.). At the same time optimization is about ensuring required staffing to meet the traffic demand.

Airlines set objectives for the optimization and in general optimization limits the budgeted number of pilots, keeps costs at minimum level, ensures that all flights are staffed properly, but also optimizes pilot satisfaction by delivering rosters that meet individuals´ preferences (Maenhout & Vanhoucke 2011, 200.).

2.5 Crew management system

Crew management system (CMS) is a software offering tools for airlines to plan their resource allocation in various ways. The software is needed for automated processes where modules of crew planning and scheduling is taken care with integrated systems allowing to make sure qualified personnel is available for the planned operations. Crew management systems offer optimization tools for airlines that reduce costs and improve efficiency in operations, both in preplanning phase and during distractions (Fortune Business Insights 2023).

Rostering software and computers play major role in crew planning processes. Main drivers in software development are the scale of the operations, cost driven mindset and increased regulation base as the understanding of crew fatigue and relationship with flight safety has risen. As airlines have become bigger, the complexity of changing network and rules and regulations require more computing power. Software has been developed during last decades from one software to integrated systems with APIs, cloud computing and crew applications (Altexsoft 2020).

Software implementation requires significant investments from the airlines both in licencing and software development services, but also considerable amount of training for the users. Software providers develop their products and grow their market shares by mergers and acquisitions. Examples of CMS software providers (Fortune Business Insights 2023):

- CAE
- IBS
- Jeppesen
- NAVBLUE
- Lufthansa System NetLine/Crew
- AIMS

3 Employee satisfaction and roster practises

Job satisfaction and different factors affecting motivation in work life have been studied widely. Covid19 was a disaster for aviation and many professionals left the industry for early retirements or changed to other sectors due to unsecure job situation. As the recovery after lift of travel restrictions was rather fast, airlines have given more interest how to ensure and attract new pilots (Murray & Green, 2023).

Motivated employees are valuable to any organization as the productivity is higher and operational performance is higher (Shan & Tang 2022, 29.) and these elements are even more important during distractions. On the other side, when employee morale is low, the motivation to work when extra effort is needed declines. Low motivation leads to higher absence and people leaving the profession or industry, increasing the overall costs for airlines with recruitment and training, delay costs and cancellations (Bamber, Gittell, Kochan & Von Nordenflycht 2009, 189.).

3.1 Declined pilot job satisfaction

Vulturius, Budd, Ison and Quddus (2024) in recent publication on pilot job satisfaction found that while studying pilots´ satisfaction pre-Covid and post-Covid following Hertzberg's sixteen workplace factors, overall job satisfaction had decreased. Largest negative change has been found factors related to salary, job security and working conditions. Further, it has been found that pilots find work-life balance, rosters characteristics and bidding processes affecting their job satisfaction levels (Vulturius 2023) both as motivators and hygiene factors. This underlines roster practises importance in airlines and some airlines have already adopted flexibility for aircrew to select fixed roster or flexible roster practises as one of the benefits to attract new employees (Maszczynski, 2022).

Crew planning in literature concentrates quite often on costs and efficient use of workforce and this perspective is valued especially during the times when airlines´ economic situation is challenging. Cost efficient crew planning might although mean that rosters are less satisfactory for the crew members (Thiel 2004, 93.).

Rosters are one part of employment relationship and according to previous studies high quality of the employment relationship predicts higher level of service quality, better labour, and aircraft productivity, not to mention effect on operating margins (Bamber et al. 2009, 84.).

Crew planning affects directly to pilots working hours and times by publishing rosters. Pilots are offered according to company policy (or by union agreement) different ways to present their preferences (pairings, morning duties) for final roster. Kohl & Karisch (2004, 235.) present how preferential bidding systems draw large attention and expectations from the crew member unions and goal

is to deliver those bidded priorities (and keep pilots happy). At the same time the whole planning system is about managing expectations and final satisfaction level among crewmembers is the ratio between expected result and delivered roster.

3.2 Different ways to allocate duty

For crew rostering three different approaches dominate flight crew planning: bidlines, personalised rosters (preferential bidding) and fixed rosters (Maenhout & Vanhoucke 2011, 195.). Most carriers in USA have used bidlines and majority in Europe have adopted personalized rostering (Addelghany & Abdelghany 2016, 99.) where individuals state their preferences as part of the bidding process.

3.2.1 Personalized roster

In this process, individual flight crew members are allowed to state (bid) their preferences according to predefined list (days off, morning shifts, destination). Crew seniority can be awarded, and planning software tries to meet the preferences at acceptable level to deliver at least some level of preferences in final roster to all flight crew members, regardless of seniority. The minimum (delivered) list of preferences is called also as a fair rule where fair-and-equal principle is respected (Addelghany & Abdelghany 2016, 99; Maenhout & Vanhoucke 2011, 195.).

3.2.2 Fixed roster

Fixed rostering is crew rostering concept where pattern of working days and days off are fixed in advance. These fixed blocks of off/on alternate in foreseen ways and offers more predictability for the crew member. This kind of arrangement is one of the tools for airlines to attract workforce although the fixed roster is not usable for all airlines (Novak, Badanik, Brezanakova & Lusiak 2020, 6.).

Fixed roster is also tool to tackle fatigue as more consecutive rest is planned (than FTL minimum). Also, for crew planning process fixed rostering removes some other restrictions as days off requests would be removed (Novak et al 2020, 6.). Maenhout & Vanhoucke (2011, 196-205.) highlight that fixed roster model is usable in situations where demand patter is similar in longer period and not all pilots are forced to same system.

3.2.3 Bidlines

In bidline approach crew planning organizes in advance anonymous lines of duty for whole rostering period. These lines are then opened for flight crew bidding, in USA according to the seniority. Pilots bid suitable bidlines according to their personal needs (vacation, days off).

The good side for the pilots in bidline system is that individual knows while bidding what kind of roster is offered and after bidding possible granted. Compared to the preferential bidding, where crew member tells (bids) the system what kind of features the final roster should include, in bidline crew member already sees at bidding phase the available roster. At the same time the concept includes more steps than preferential bidding system. The bidline approach is for the airline a little bit tricky as due to pre-assignments and vacation days some bidlines cannot be assigned (Kohl & Karisch 2004, 225.).

4 Rules and regulations in roster planning

As described in earlier sections, there are several rules and regulations that must be followed. Kohl & Karisch (2004, 228.) define rules and regulations for crew planning as conditions under which a roster is considered legal or not. These rules can be formed due to legislation, by authorities (in Europe EASA and in USA FAA), by airline or due to requirements in collective labour agreement (CLA). These rules must be adopted to the planning software guiding both crew pairing and actual scheduling.

Some of the most common restrictions are related to rest and flight duty limitations and crew qualifications restricting the rostering. Kohl & Karisch (2004, 230.) categorize different rules in crew planning vertical, horizontal, and artificial rules following Gantt -chart based roster presentations.

- Horizontal rules: required rest periods and patterns (consecutive days) between duties, planned absence (vacation, for example). Accumulated values (flight legs, duty hours, block hours on specific time length)
- Vertical rules: crew combination (augmented crew or check flight requiring more than two pilots), leg (challenging airport) and task qualification (inexperienced crew member). Global rules for the result (for example, bid satisfaction at certain level)
- Artificial rules: additional requirements by the airline to increase robustness (reliability, stability) of the rosters. This could be, for example lower duty hours per month due to experienced delays in actual operations.

In this study, when listing flight crew duty limitations, EASA Flight time limitations (FTL) are presented as a base. On top of these absolute limits by authorities, additional restrictions are required by dedicated CLAs and might be completely unique.

4.1 Applicable legislation and contracts

Crew planning and rostering context touch multiple applicable laws and additionally CLA often gives guidance to the actual airline practises. These rules must be followed, and rules are adopted to the planning software guiding both crew pairing and actual scheduling.

4.2 Rest period requirements

EASA FTL defines rest period as “a continuous, uninterrupted and defined period of time, following duty or prior to duty, during which a crew member is free of all duties, standby and reserve”. Flight crew is required to have periodically minimum rest periods and required lengths vary in regards of

home or out base rest, previous duty length and possible time difference. Additionally, to tackle cumulative fatigue, extended two consecutive local nights and 36 hours rest is required every 7 days (EASA 2014).

4.3 Flight time and duty limitations

Flight crew duty times are calculated both by duty and flight time, extending the observation to daily, weekly, monthly, and annual limitations. Flight time starts when aircraft starts taxing and end when aircraft comes to full stop and all engines are shutdown. For duty time additional work is also observed and may include flight preparations and after flight duties, computer-based trainings, and simulator sessions (EASA 2014). Daily duty time is limited also depending on the time of the duty (night hours) and sectors to be flown as these increase the overall fatigue (EASA 2014).

EASA limitations for total flight time are:

- 100 flight time in any 7 consecutive days
- 900 flight time in calendar year
- 1000 flight time in 12 consecutive months

4.4 Qualifications

Flight crew qualifications dictate what kind of operations individual pilot may participate. According to regulations it is the responsibility of the operator to make sure that all flights are manned with qualified pilots according to aircraft certification (EASA 2014). In practise this means for crew planning following qualifications to be considered:

- Aircraft type
- Instructor or examiner
- Challenging airport or flight route requiring specific training
- Inexperienced crew member

4.5 Seniority

Flight crew members are ranked in airlines according to the seniority number, based on the date of the hiring (Clinton & Hansen 1997, 40.). The impact of the seniority list position is unique to the airline and regional differences exist. In flight crew planning and especially in crew scheduling phase the allocation of different duties and individual preferences may be given more value according to the seniority. Strict seniority rule is mainly used in North America when crew rostering problems are solved (Kohl & Karisch 2004, 252.).

4.6 Roster publishment and robustness

Roster publishment refers to date when the next working schedule is announced to the crew member. On a global level roster publishment is handled as a part of means to manage crew fatigue and same also applies EASA as the aviation authority in Europe. For applicable national law in Finland, the Working Time Act applies. The guidance is written in following words:

- ICAO: “rosters need to be published sufficiently in advance to allow crew members to plan for work and rest periods” (IATA, ICAO & IFALPA 2015, 43.)
- EASA: “An operator shall publish duty rosters sufficiently in advance to provide the opportunity for crew members to plan adequate rest” (EASA ORO.FTL 110)
- Working Time Act: “Employees shall be informed in writing of the work schedule well in advance and no less than one week prior to the start of the period covered by the work schedule” (Working Time Act 872/2019, section 30)

Further, EASA offers guidance to air operators with Acceptable means of compliance (AMC). For roster publishment EASA advice that “Rosters should be published 14 days in advance” (EASA 2016, 189.). For this specific guidance, EASA has been noticed by national authorities for AltMoc -approvals for 13 airlines (EASA 2024).

Robustness EASA prescribes as the stability or reliability of the published roster. Robustness should be observed comparing the planned duty time and actual duty time (delays) point of view. The actual process is left to the operators and overseen by the national aviation authorities.

5 Crew rostering and planning

The crew planning is part of airline resource planning, and the basic idea is to ensure all flights are manned with qualified persons. Before airline can start crew resource planning, there must be a plan based on commercial decision where to fly, when and aircraft types to be used.

5.1 Scheduling process

According to Maenhout & Vanhoucke (2011, 194.) personnel costs in aviation are the second largest cost area (30%) after fuel. This highlights the importance of efficient resource planning as improper use of resources may turn to chaos both operationally and financially. Planning is about analysing different constrains and different steps in process can be presented as problem solving.

Ernst et al. (2004, 5.) present planning process as 6 modules:

- Module 1. Demand modelling: duties to be performed is calculated from the schedule and expected service.
- Module 2. Days off scheduling: every line of work is followed by required days offs and affects resource calculations.
- Module 3. Shift scheduling: different duties are combined and number of employees per duty is fixed to meet the demand.
- Module 4. Line of work construction: individual duties may be constructed to follow each other, especially when operating outside home base. Also, depending on flight lengths, multiple sectors may be combined as line of works.
- Module 5. Task assignment: some duties may require special skills or experience, and these are added to requirement lists.
- Module 6. Staff assignment: individuals are assigned to tasks and individual roster is formed.

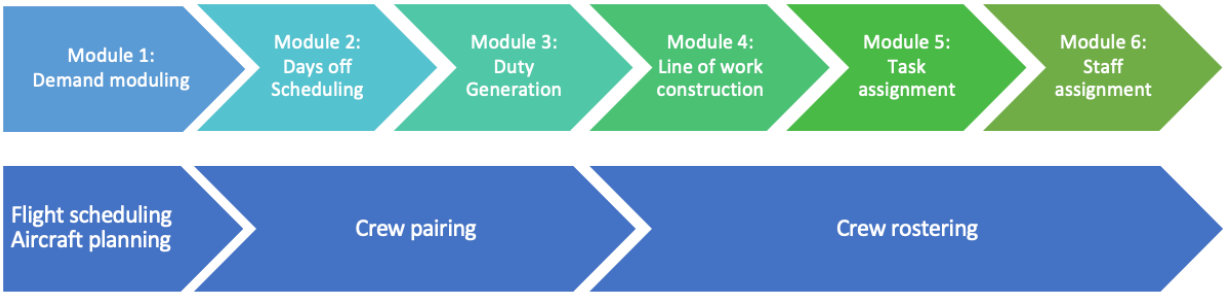

Figure 3. Planning modules in airline crew scheduling (Adapted from Maenhout & Vanhoucke 2011, 195.).

Figure 3. presents general resource planning process. In aviation business, modules are usually separated as long-term planning (flight schedules, aircraft planning), crew pairing and crew rostering modules (Maenhout & Vanhoucke 2011, 195.).

The planning process follows these steps periodically (normally on monthly basis), but not all modules must always be used. For example, if the airline has fixed time schedule for consecutive months (summer season, winter season), only part of the modules is needed on monthly basis. On the other hand, if the demand changes for commercial reasons or due to lack of aircraft, this might mean also more active use of earlier stages of crew planning modules.

One of the airline key performance indicators (KPI) is aircraft utilization. Aircraft and fleet flight hours are measured on daily basis and effective use of aircraft is essential for any airline. Airlines report ASKs periodically, but at the same time it is relevant how many aircraft are needed for the network (Meijer 2021, 153.).

5.2 Crew pairing

As the first problem in planning, the flight schedules and allocated aircraft has been solved, next step in planning process is the crew pairing optimization. In crew pairing module individual flights are combined as tasks and depending on the flight length or schedule, these flights can be handled with roundtrips or pairings (Maenhout & Vanhoucke 2011, 195.). Crew pairing must also work in advance with the aircraft planning and flight scheduling phase as too tight scheduling optimizing both aircraft and crew utilization might during delays affect negatively to the airline network later (Meijer 2021, 181.).

Due to this problem pairing phase considers minimum aircraft and crew turnarounds as a part of the pairing building. As it can be seen in Figure 4. every pairing has activity information that includes, for example reporting time (RT), standard departure (STD), flight time (FT), standard arrival time (STA), closing time (CT, end of duty) and time away from the base (TAFB). This information is

later needed when pairings are combined, and different rules and regulations are to be followed. Additionally, when pairings are formed by combining several flights, these combinations of consecutive flights must also follow additional, possible cumulative rules and regulations and CLA requirements.

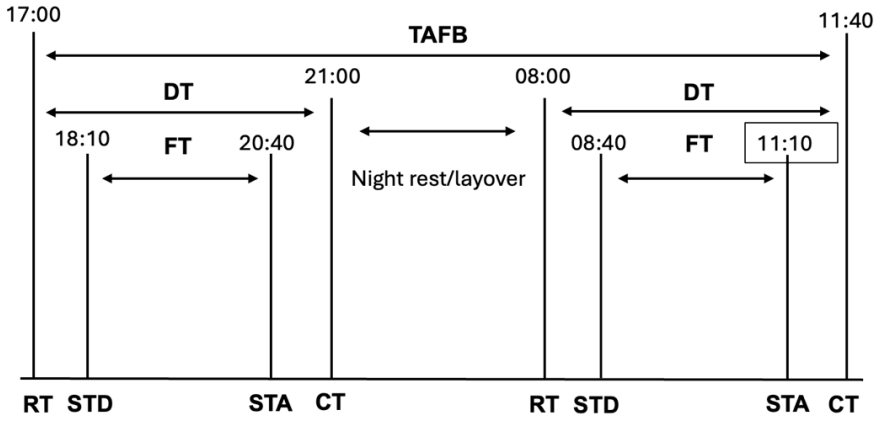

Figure 4. Pairing example of two flights with layover (Adapted from Manhout & Vanhoucke 2011, 197.)

Pairing phase also considers different options to meet the demand. Andersson et al. (1998, 230.) highlight that the crew pairing phase is the most important for the cost savings as these combinations are in later stages allocated to crew members as such. Pairing phase also allows planners to evaluate different options to fill the flights by combining several return flights as pairings (Figure 5.) and depending on the airline network, use crews for consecutive days in other than home base. Depending on the crew bidding system and airline network, bidlines or preferential bidding system, the pairing structure can be longer.

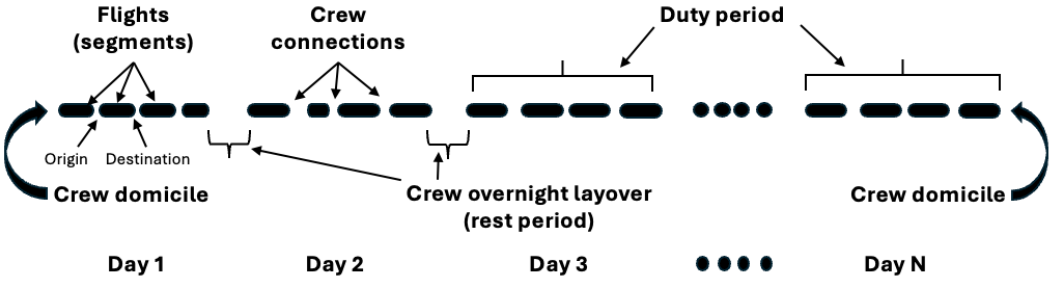

Figure 5. Example of multiple segments in single pairing (Adapted from Abdelghany & Abdelghany 2010, 90.)

As the pairing phase optimizes both cost and crew utilization, and the airline demand changes (peak times, holidays and change of schedule), pairings are not always identical. Pairings must be

built differently, and optimized result may give more value for cost (shorter duty) or just fill all the flights with longer duty times (Andersson et al. 1998, 234-237.). For costs, rules and regulations different requirements for pairings are introduced via legislation and crew work rules.

Thiel M. (2004, 92.) emphasizes that pairing structure can also affect crew satisfaction and by introducing longer pairings (team-oriented airline crew rostering) with same team, crew satisfaction could be increased. Kohl & Karisch (2004, 234-235.) mention that when pairings are constructed in North America, unpopular pairings are minimized in bidlines, and these can be, for example night duty and one-day working periods. On the other hand, for unassigned activities, filled by reserve or standby during the rostered period, it is more cost efficient to offer three unassigned one-day pairings than one three-day pairing (Kohl & Karisch 2004, 91.).

5.3 Crew rostering

Last part of the crew planning is the actual crew rostering, where planned activities are appointed for the individual crew members while all rules are followed and announced objectives are met (Abdelghany & Abdelghany 2010, 99.). Some rules limit the window when crew member is available for tasking (vacation, other leave of absence) while some regulations offer wider window how and when requirements are to be solved (weekly rest, block hour limitations). Different inputs affecting crew rostering can be seen in simplified way in Figure 6.

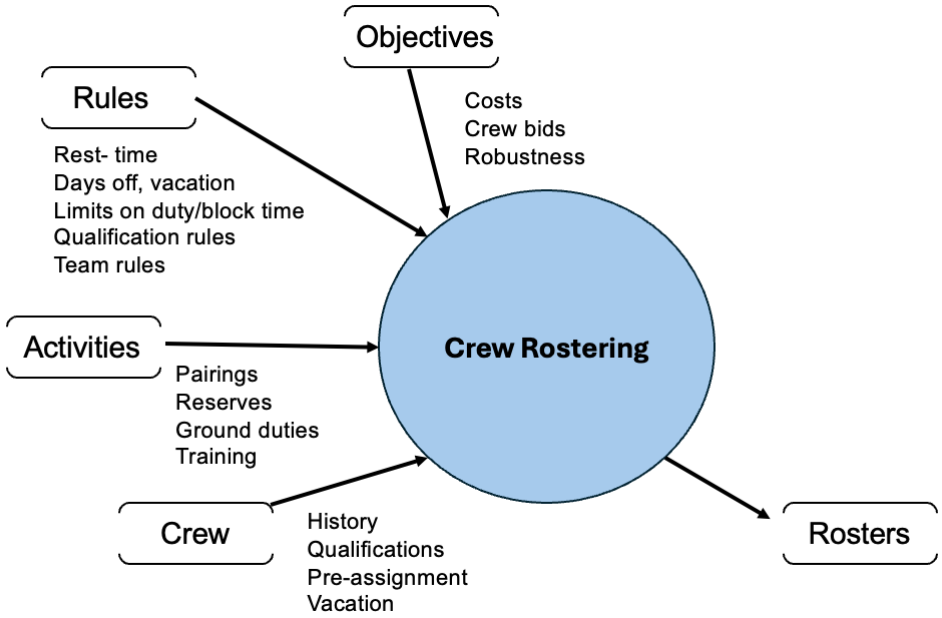

Figure 6. Airline rostering problem and different inputs (Adapted from Kohl & Karisch 2004, 228.)

In contrast to crew pairing phase, crew rostering phase concentrates on distributing tasks (pairings) to pilots while meeting the aircrew preferences. Traditionally these two phases are handled in

optimization separately, but it is notable that poor pairing structure may also result to poor crew bid satisfaction levels. Quesnel, Desaulniers & Soumis (2019, 97.) suggest that with better integration of pairing and rostering and introducing crew preferences also to pairing phases the overall satisfaction level related to rostering among aircrew could be increased. In computer-based software this would mean that when rostering phase could not meet for example, afternoon bid off for crew, original pairings could be split and distributed by new round of optimization.

5.4 Aircrew preferences in rostering

Aircrew preferences in rostering phase are collected with bidding feature. In general, this means that every individual can present their needs for the result, but the applicable rostering system -bidlines or preferential (personalized) bidding dictates how this is done.

One of the biggest preferential bidding system (PBS) providers, Jeppesen, presents their solution for aircrew bidding as bidding modules that are selected (Jeppesen 2024):

- Strict Seniority PBS with points
- Bidding is awarded strictly by seniority, either by days off or with dynamic bidlines
- Strict Seniority PBS: Bid groups
- A rotating seniority model where group of pilots in turn are awarded higher priority
- Fair Share PBS
- Crew members set preferences with priorities. Preferences are awarded either equally or by introducing seniority
- Lifestyle
- Long term requests for morning or evening shifts, repetitive days off for certain weekdays
- Crew Request
- Days off requests that can be distributed with weighted value (seniority, priorities) or first-come-first-serve

One additional element is the bidding timeline, and this is left for the airlines to choose, often agreed with the pilot union. Additionally, one important part of aircrew rostering is the shift exchange after roster publishment, but this area is left outside of this study.

6 Research methods and approach

The research method is usually selected between quantitative and qualitative approach, depending on the research topic and goal. In qualitative research the data is collected and analysed in non-quantitative ways. The information or data can be collected from various sources and can consist, for example interviews, documents, internet sites and human experiences of others, depending on the goals of specific research (Saldana 2011, 4.).

The umbrella of qualitative research includes variety of genres, and the study may include as a mixed research approach both quantitative and qualitative data collection to improve the depth of understanding. One of the qualitative research genres is case study, where the study focuses for example, to one group or organization but may also include multiple cases simultaneously (Saldana 2011, 4-9.).

As the main goal of this study was to understand how and what kind of different practises have been enabled rather than how well huge mass of line pilots think the practises work, the pure quantitative method was not selected. Research method was mixed research, combining quantitative and qualitative approach. Due to research topic, open questions and room for written clarifications were important for deeper understanding. At the same time, it was important to limit both respondents' number (airline respondents rather than "all pilots") and not to make the analysis too complicated.

Part of the questionary was also picked so that answering requires some level of understanding how rostering evaluation takes place and how the employer and labour organization act together. This means also that it was more important to receive responds from right people rather than right number of pilots.

6.1 Survey preparations

The survey process planning followed the framework by Schonlau, Fricker & Elliott (2002,31.), presented in Figure 7. For questionary, meeting with Finnair Crew Planning and Flight Operations management was organized and future development needs were identified. Additionally, as the crew rostering is handled as a part of collective labour agreement with Finnish Air Line Pilots´ Association (SLL), representing Finnair pilots, the union board gave their inputs for the questionary.

Survey link was published at the end of the March 2024 and scheduled to match the gathering of European Cockpit Association Industrial Working Group spring meeting in Brussels. This timing was ideal for building awareness of the pilot representatives and supported private, direct contacting referring to the info shared in the meeting. The survey link was open for replies for two weeks.

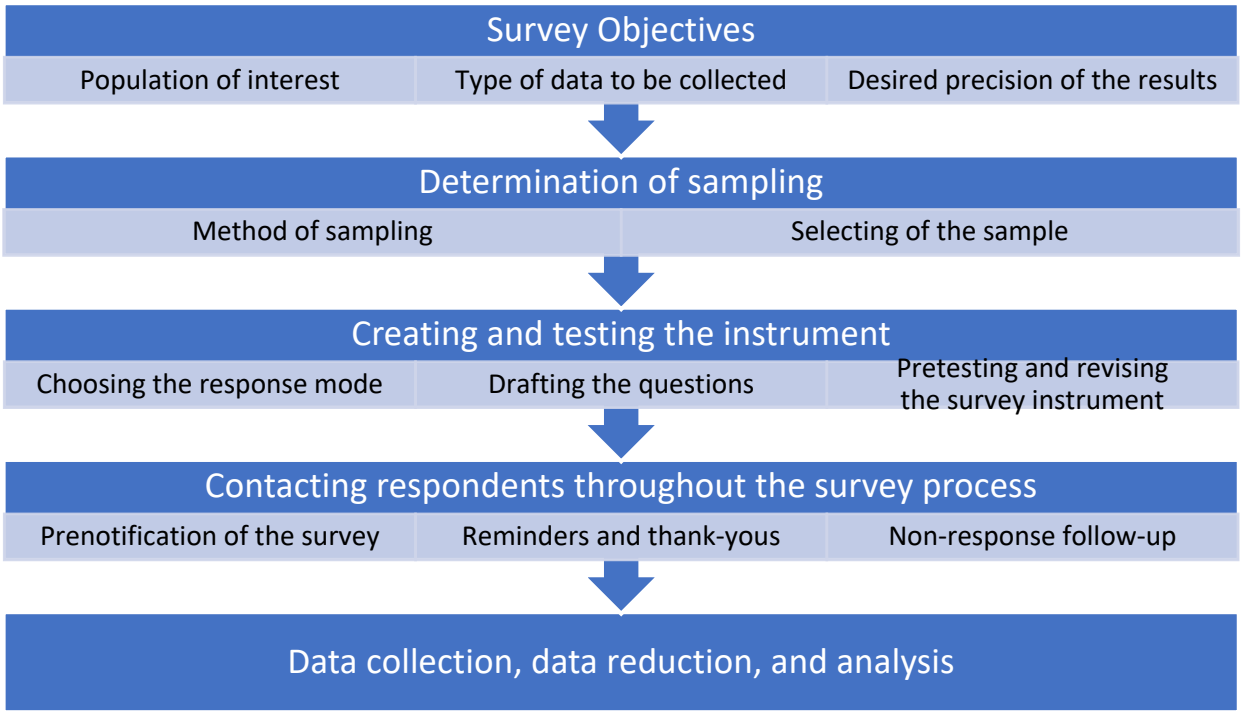

Figure 7. Overview of the survey process (Adapted from Schonlau, Fricker & Elliott 2002,31.)

6.2 Data collection and analysis

Data collection was organized with SurveyMonkey professional survey software. The software was familiar to the author from previous studies organized among pilot associations. The software is used by 17 million users worldwide and over 20 million questions are answered on daily basis (SurveyMonkey, 2024). SurveyMonkey software was also used for data analysis as it offers possibility to sort and evaluate data according to background questions.

Survey link was shared via email list to European Cockpit Association Industrial Working Group with representatives from over 20 European Union States and national pilot associations. Additionally, some individual requests were sent to known pilot representatives from major airlines. This kind of sampling could be described as convenience sampling. In convenience sampling the respondents are not randomly selected and some restrictions are present if statistical analysis would be needed. At the same time convenience sampling does not mean that results would be unreliable, and respondent may offer valuable input for the research topic (Schonlau, Fricker & Elliott 2002, 33.).

7 Results

This chapter presents the questionary findings by introducing first the background of the respondents and then by three sections according to original research questions. Short overview of open question responses is presented last. The questionary is presented in Appendix 1. for a closer look.

7.1 Participating airline representatives and background

Survey was able to reach 28 European airlines. As seen in Table 1., following the majority categorization by Magdalina & Bouzaima (2021, 7) of the responses represent full-service carriers. Additionally, some airlines were not part of the 49 airlines study. These originally non-categorized airlines were Norra (regional carrier for Finnair), CargoLux (cargo operator), Plus Ultra (Spanish long-haul operator), Discover (leisure flight operator), Jettime (Danish leisure operator) and Wamos Air (wet lease operator).

No	FSC	Hybrid 1	Hybrid 2	LCC	Originally not categorized
1	Air France	Aer Lingus	airBaltic	EasyJet	Norra
2	Austrian Airlines	Condor	Croatia Airlines	Ryanair	CargoLux
3	British Airways	Icelandair	Eurowings	Transavia	Plus Ultra
4	Brussels Airlines		Luxair		Discover
5	Finnair		Widerö		Wamos Air
6	Iberia		Iberia Express		Jettime
7	ITA airways				
8	KLM				
9	Lufthansa				
10	SAS				

Table 1. Represented airlines in the survey following the categorization by Magdalina & Bouzaima (2021, 7.)

According to the survey results, Jeppesen and Lufthansa Netline/Crew are the most popular software in crew rostering in Europe (Figure 8.). 11 airlines used Jeppesen products and 7 airlines Lufthansa Netline/Crew software. Those who selected “other” in software question clarified their answer and are using smaller CMS providers or answered “unknown”. This rather concentrated use of Jeppesen and Lufthansa Netline/Crew software supports further comparison between different bidding practises as from software point of view opportunities and build-in limitations are similar in these two groups.

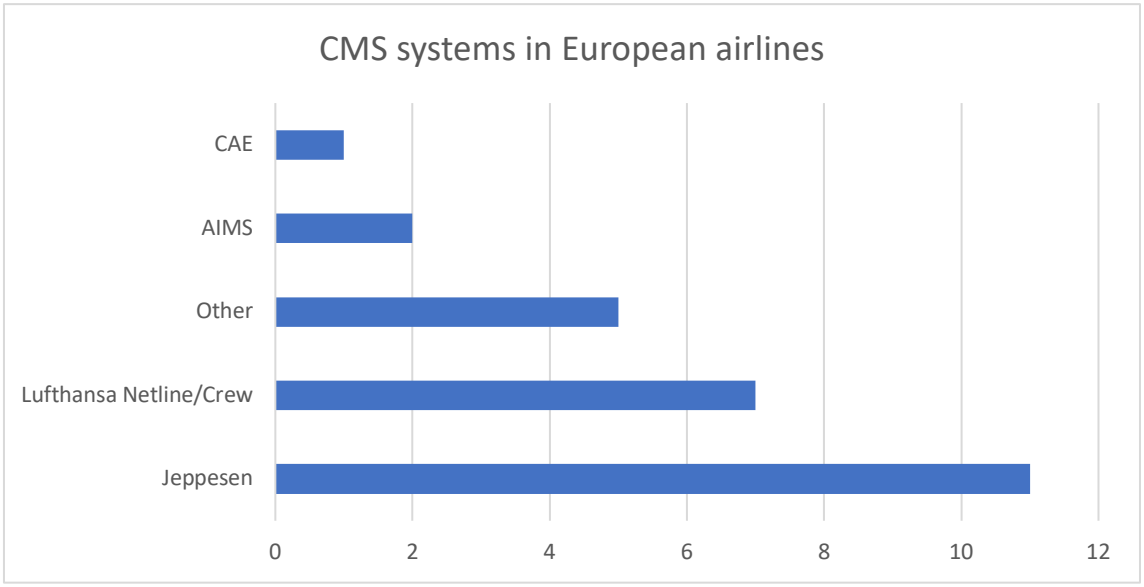

Figure 8. CMS software used in European airlines´ crew planning (N=26)

Rostering practises seem to be dominated by preferential bidding (over 70% of replies) and this was also stated by Addelghany & Abdelghany (2016, 99.) to be reality in Europe. Some airlines are also using the fixed roster model, either as only option for the pilots or based on voluntary, optional selection for the pilots.

For roster publishing, majority of airlines (over 90%) are using calendar month for rostering. Those airlines using alternative means had either rolling period (for example, three weeks visible all the time) or rostered period have been modified for number of days and this could result rosters for example, period of 27 days between January 2.-29. and next roster period including days both from January and February.

EASA AMC guidance for date of roster release (“Rosters should be published 14 days in advance” EASA 2016, 189.) is visible in airline practises as 14 airlines out of 26 announced their rosters

being published 14 days prior the rostered period. From the data it is also visible (Figure 9.) that several airlines have applied EASA Alt-Moc procedure as they are publishing rosters later than the AMC states. Figure 9. also shows the planning phase length in airlines by comparing the time difference between roster publishment and days off bidding deadline for pilots. Majority of airlines, 15 out of 28, require pilots to state their bids 20-30 days prior rostered period. Iberia used according to written clarification clearly defined different bidding deadline to short-haul and long-haul pilots and is presented in Figure 9.

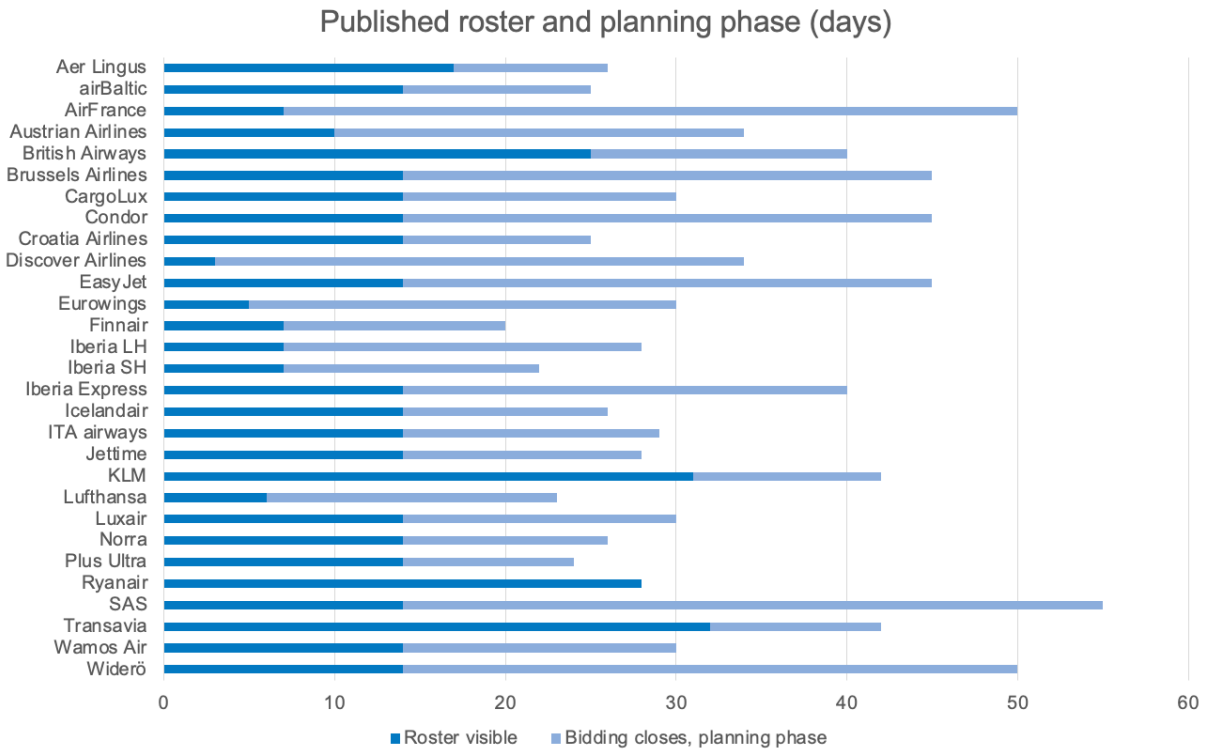

Figure 9. Pilots roster publishment and bidding deadline (n=29)

Some respondents informed in open questions that airlines require instructor and specific bases to bid earlier than other pilots or limit the days off bidding possibilities by pilot groups. Additionally, as type of operations may require different approach to the rostering, short and long haul may have different dates for pilots. This difference in short haul and long-haul operations is visible in Iberia where long haul pilots are required to state their bids few days earlier than short haul pilots. Interesting information was that similar airlines by network under same airline group may be handled differently: Iberia short haul pilots receive their rosters later than Iberia Express pilots. Another interesting fact was that some airlines that publish their rosters well in advance compared to others may only publish the full days off for pilots and full information for destinations and start or end of duty is published much later.

7.2 Pilots´ possibilities to state their preferences

When analysing pilots´ possibilities to influence days off on becoming rosters, the roster practise (bid lines, preferential bidding, fixed rosters) must be considered first. In fixed roster model, despite the “fixed” days on and off, according to answers pilots have some limited options to state days off needs against their normal pattern. Due to planning model and other pilots relying on their on-off pattern, these requests are to be made well ahead (for example, two months prior) and amount of allowed requests are kept annually low. Additionally, pilots may request unpaid leave of try to change duty with other pilots.

Figure 10. shows different options for pilots to arrange required days off. Respondents were allowed to select several options, and this also shows that there are more than one options available. Preferential bidding in some airlines have evolved to the arrangement where pilot may bid both specific days off, but also bid certain pairing that is known to be followed by fixed number of recovery days at home base.

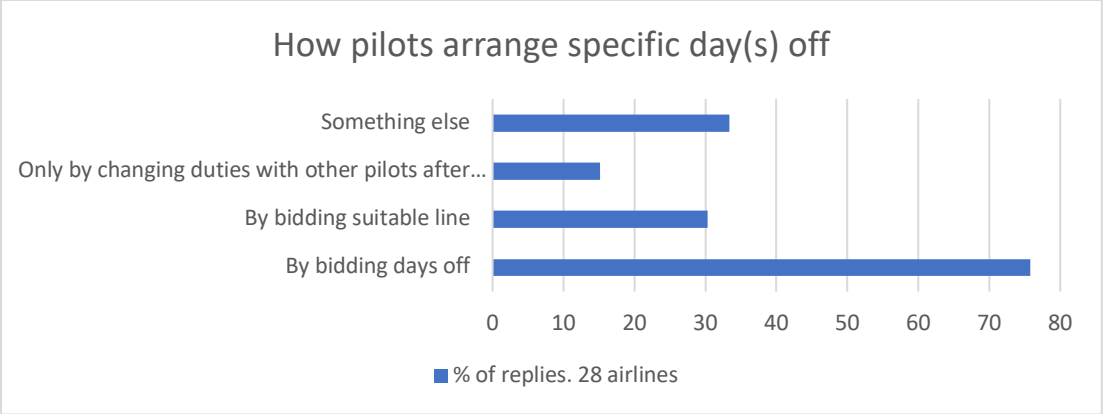

Figure 10. Pilots possibility to arrange specific days off (N=28)

In prefential bidding pilots are allowed to request days off more freely as there are no fixed duty or days off in general. Some respondents reported in open questions that for flight instructors the window for days off bidding may be much earlier than for the other pilots. Many airlines must plan their training (simulators, line training) earlier than normal rostering as there are more qualification-based requirements present. This seems to also restrict possibilities for the instructors and students to state their preferences as their training slots are fixed before the actual bidding is started.

Among FSC group average number of monthly days off requests was 4,11 with results varying between 1-6 days. Few respondents clarified that the software itself might not technically restrict number of days off requests, but as the airline will plan required amount of flying to the pilots anyway, bidding unrealistic numbers of days off just ends to majority of bids to be disregarded.

Number of days off bidding in Hybrid 1 and Hybrid 2 groups in average were clearly higher (5,7) than those in FSC. Main reason for higher average was few airlines that allow 9 or 12 days off requests to be bidded, but behind higher days off bids was more details available in clarifications: with higher number of days off bids the bids may be required to be used in pairs or by several consecutive days.

On top of days off bidding, pilots are allowed to influence their rosters on several other means to meet better individual needs. Figure 11. offers the view of the most common preferences that pilots use on monthly basis. Noticeable is that preferences are concentrating on days off bidding, destinations, and time of check in or check out. At the same time airlines that use fixed rosters offer limited or no possibilities for individuals to state their preferences for the planning phase, but pilots may change duties with colleagues after roster is published.

Those who selected “something else” offered valuable insights from the practises. For example, in long haul pilots may state preference for different regions and depending on the software capability also standby duties and simulator buddy tasks. Additional feature was also possibility to bid weekend off.

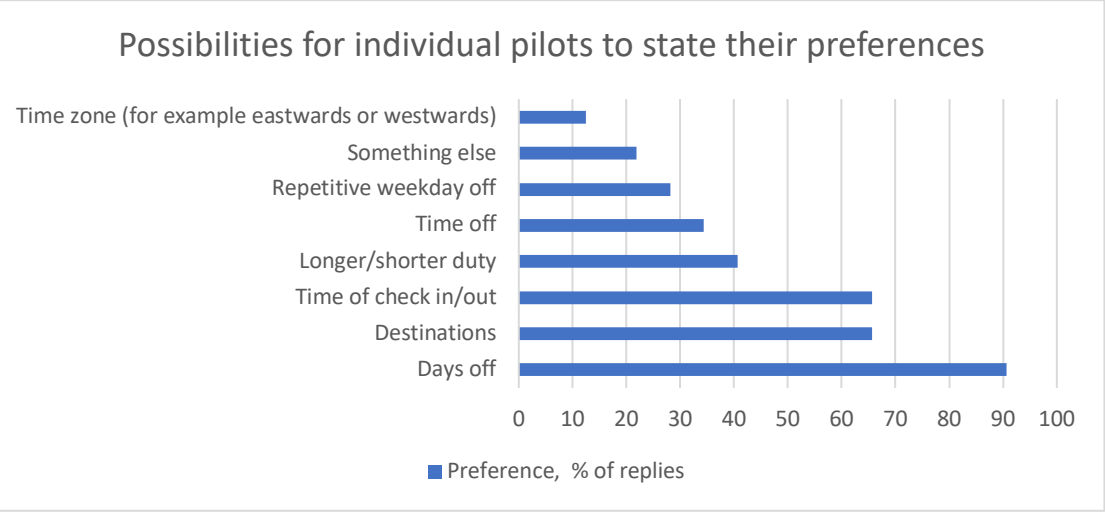

Figure 11. Pilot possibilities to state their preferences (N=28)

7.3 Objectives for satisfactory results

Another factor in roster planning is the actual result and how the final product meets the objectives. These objectives according to Figure 6. can be for example, costs, crew bids (pilot preferences) and robustness. According to the results (Figure 12.), airlines in general have agreed the level of satisfaction targets with the pilot association. FSC carriers reached slightly more positive result (3,36) while all airlines receive clearly lower grade (3,09).

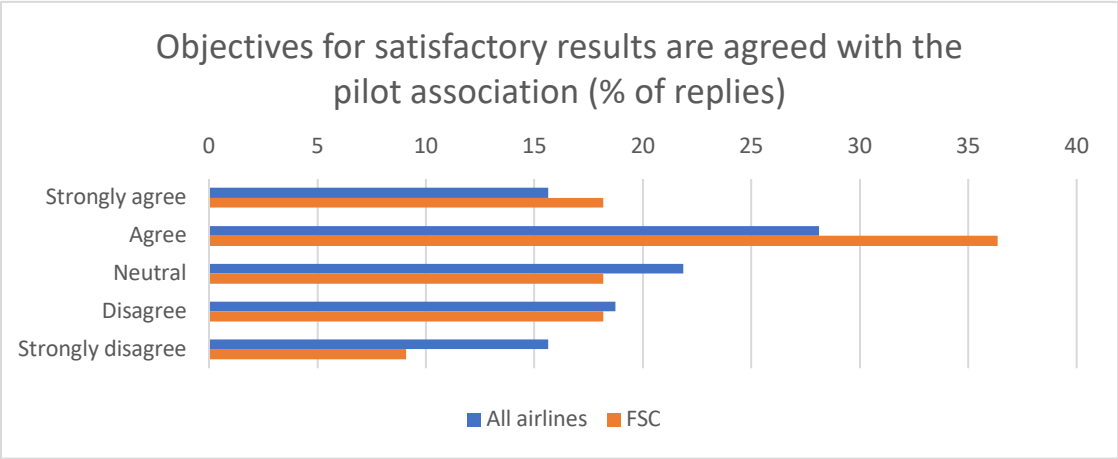

Figure 12. Objectives for satisfactory results and possible agreement with the pilot association (N=28 for all, 10 for FSC)

While the target was relatively randomly agreed and FSC carriers performed better, the practises how often pilots´ satisfaction was measured was surprisingly low. Over 45% of respondents stated that pilots´ satisfaction is never measured. Only 7 airlines out of 28 was analysing results on monthly basis. At the same few respondents stated that while feedback may be collected and results measured, there seems not to be any visible changes in rostering practises by the airline.

7.4 Transparency and predictability

Survey offered view also to the transparency in rostering and how different fairness functions are used in planning phase. Figure 13. shows how popular different schemes are in European airlines. Most popular concept was the seniority. Among those selected “something else” was visible practise where better priority was given for those pilots bidding lower amounts or their bids have been granted with lower success during previous months. This “something else” also includes responses of “no means at all”.

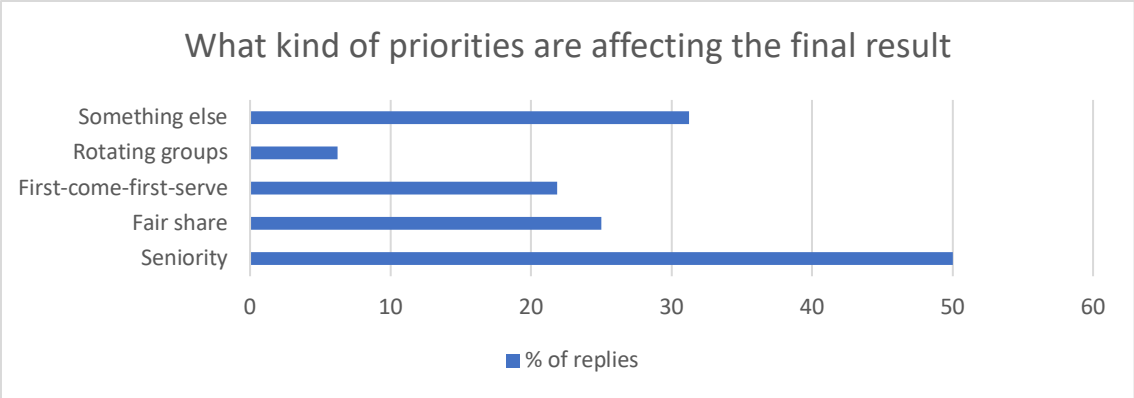

Figure 13. Priorities affecting the rostering and granting preferences (N=28)

While airlines used predefined rules how possible multiple similar bids are handled, other factor in predictability is the likeliness of requested days offs to be granted. As noticed previously, majority of airlines offered at least some means of requesting specific days off regardless of the rostering arrangement. According to results, pilots can trust their days off bids to be granted rather likely (3,71). At the same time it is important to understand that there was huge difference how many days pilot could bid on monthly basis and when few individuals represent huge amount of pilots, there might be inside pilot groups some variations.

Another tool to build transparency and predictability is the feedback during the bidding how likely individuals´ bid could be granted. This kind of information sharing seems to be rather minimal as results present negative values (2,69, N=28). This value should be observed together with the fact that pilots may be required to bid their days off for the next roster period over month prior the roster is published and during that time pilots are completely unaware what to expect.

7.5 Pros and cons in pilots rostering

Last question in the survey was an open question and offered participants shortly prescribe the present advantages and disadvantages on rostering. These answers were grouped to similar topics and offer another valuable aspect for comparisons and rostering development.

High value was given for high success rates, clear rules in priorities, possibility to select either fixed or variable roster, communication by planners, and available practises to request day off for high priority needs.

Disadvantages included topics around low success rate in bidding, unclear processes and rules, software-based limitations, major biorhythmic changes, late roster publishment and changes on short notice and lack of rostering development despite of given feedback.

8 Conclusion

This study was able collect and present the rostering practises used by 28 European airlines. The questionary summarized different rostering models, pilots´ possibilities to influence their rosters and open questions offered deeper understanding of different practises. Even though two CMS software providers dominate the market, airlines use software differently even inside same airline group and with similar network.

Regulative framework in rostering is by flight duty and rest periods the same by aviation authorities, but there are several CLA based specialities that make comparison between different models challenging. There is not any industry standard to be found and even those airlines that already offer several means for their pilots to state their preferences may find new tools to improve rostering and pilots´ job satisfaction.

Clear need for improvements is to be found around communications, clear and predictable rules and offering flexibility for the pilots to state their preferences according to their needs. Surprising high number of airlines are not analysing pilots´ satisfaction to the rostering and seems to leave one really important area related to shift working undeveloped. Table 2. presents findings according to research questions.

Research question	**Solved in practise**
How pilots are enabled to state their preferences for roster planning	**Fixed rosters** allow only limited options for pilots. Annual budget of few special day off requests offered. **Personalized rosters** allow multiple ways for pilots state their preferences, but variations are present in airlines even when using completely same software. Days off, destinations and start/end of duty most common practises. **Many airlines have their unique "special" day off bidding** practises as variable rosters and late publishment of roster mean unpredictability for pilots.

	Bidding deadline for pilots varies, but most commonly between 20-30 days prior rostered period.
How the objectives of preference satisfaction have been set	Airlines have **rather rarely agreed** the objectives with pilot association and FSC perform better. The satisfaction to roster practises is **rarely measured** among pilots.
How transparency and predictability in roster publishment has been solved	There is imminent **lack of transparency present**. **Seniority and fair share used most** for prioritizing conflicting bids. As bidding and rostering includes uncertainty whether bids are granted, limited number special request day offs are used as a repair tool. For fixed roster fixed pattern alternating days off and on bring predictability. **Some airlines provide information** for pilots how many **similar bids** exist already and **some even state how many** pilots **may have day off at the same time.**

Table 2. Research questions and summary of findings in practise

8.1 Reliability and validity

By challenging the research with validation, the findings are compared to theoretical background and whether they behave like predicted according to previous theories. Results are also analysed in the way that results would not be misinterpreted due to variables and findings are logical (Taylor 2013, 20.).

Reliability in research in nutshell considers if the results would be the same if similar study would be taken in similar circumstances. Reliability could be challenged if questionary was too challenging to understand or allows false interpretation by respondents or the mood of respondent could affect the answers (Inyang, 2017, 8.).

The questionary link was shared among pilot representatives in European pilot associations that are actively participating to the pilot community under European Cockpit Association. The own

background or position of respondents was not asked and their expertise to answer dedicated rostering questions may have been limited, depending on individual's role in the pilot association.

The questionary was prepared in cooperation of pilot representatives and airline management in charge of resource planning and contract negotiations. Despite of proper preparations and testing the questionary native English speakers, some of the questions were not understood correctly and clarifications were asked by email. The rostering and practises are quite different among participating airlines and some questions might not have been suitable for respondents´ airlines or other wording would have been needed due to cultural reasons.

Some airlines, especially LCC do not have pilot representation and many airlines may have several bases in different countries with different practises and legislations behind them. Due to this fact this study findings should be considered more as an overview than a description of individual airline´s practises.

With this background the findings in this study follow in general previous theory and how airlines do their rostering. There is also visible development of CMS software and rostering practises working as a hybrid model where pilots may bid specific pairings with specific dates and rest of the roster is optimized. As airlines are developing new features to bidding, the way how the rostering process can meet the pilots' preferences change and resource situation (pilot numbers versus planned schedule) is under constant changes.

8.2 Suggestions for further research

As this study was concentrating on presenting different practises in use and possible solutions for those pilot associations looking for improvements, further research should be done how satisfied pilots are on their roster practises by using quantitative research. This study could be done as an industry wide study or limited to one airline only.

8.3 Authors own learnings on thesis project

This thesis study was an interesting path to research world and most fascinating was to find out how much there is previous studies available regarding shift work, mathematical models for optimization and resource planning. Most challenging part was to clearly define research question and try to limit the number of topics related to the rostering. Every new research found was leading to new area and point of view and could easily make the thesis project too complicated. Before this project I did know quite a lot of resource planning but was amazed how many aspects must be considered for successful planning process.

It was rather easy to reach numerous pilot representatives to share their practises and there seems to be need for overview and ideas for development in several airlines. This also applies to my own employer and pilot association that have for years looked for improvements in rostering. This clear need for ideas and results was also supporting me to keep the schedule and finish the thesis writing as planned.

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Appendices

Appendix 1. Questionary

BACKGROUND

1. My airline
2. My email address (collected only for possible clarifying questions by author)
3. What is the name of your company´s current crew management system (CMS, software)?
   - CAE Crew Management
   - IBS
   - Jeppesen
   - Lufthansa Netline/Crew
   - NavBlue N-Crew planning
   - Something else, please specify

4. What kind of rostering arrangement your airline is using?
   - Preferential Bidding System (pilot bids days/time off and presents priorities)
   - Bidlines (pilot bids pre-planned rosters)
   - Fixed roster
   - Something else, please specify

5. How are pilot rosters published (rostered period)?
   - By calendar month
   - By rolling roster period (for example, three weeks visible all the time)
   - Something else, please specify

6. How many days prior to the rostered period is the official roster published?
   - 14 days prior
   - 7 days prior
   - Something else, please specify

HOW TO STATE PREFERENCES

7. How many specific calendar days off pilot may bid/request on a monthly basis?

8. How are pilots able to arrange <u>specific</u> day(s) off on a monthly basis?
   - By bidding days off
   - By bidding suitable line/pairings
   - Only by changing duties with other pilots after roster is published
   - Something else, please specify

9. How early prior rostered period pilots have to bid their preferences (days off, lifestyle)
   - Scaler for days

10. What kind of possibilities individual pilots have when they state their preferences?
    - Days off
    - Time off
    - Destinations
    - Time zone (for example, eastwards or westwards)
    - Time of check in/out (early/late shifts)
    - Longer/shorter duty

Repetitive weekday off (for example, every Monday off)
Something else, please specify

OBJECTIVES FOR SATISFIED RESULT

11. Objectives for satisfactory results in preferential bidding are agreed with the pilot association (for example, certain level of bidded days off are granted, morning shifts etc.)
Strongly agree
Agree
Neutral
Disagree
Strongly disagree

12. Pilots´ satisfaction on crew rostering are analyzed in your airline
Monthly
Quarterly
Semi-annually
Annually
Never

TRANSPARENCY AND PREDICTABILITY

13. When days off bids are granted, what kind of priorities are in use affecting the final result
Seniority
Rotating groups (pilots in bidding groups, higher priority alternating)
First-come-first-serve
Fair share (pilot preferences awarded equally)
Something else, please specify

14. Regarding bidding specific days off for next rostering period (in “average” month), how likely requested days off are granted
Extremely likely
Likely
Neutral
Unlikely
Extremely unlikely

15. In your airline, pilots receive feedback on how likely their preference bidding is granted?
Strongly agree
Agree
Neutral
Disagree
Strongly disagree

16. Open question: what are your current rostering practises´ advantages and disadvantages from pilots´ point of view?