INSTITUTO SUPERIOR DE EDUCAÇÃO E CIÊNCIAS

ESCOLA DE GESTÃO, ENGENHARIA E AERONÁUTICA

CREW ROSTERING POLICIES AND FLIGHT CREW SAFETY BEHAVIOURS

How different bidding policies can affect flight crew's safety behaviours

JOÃO GONÇALO FERRAZ BASTOS

Examination intended to obtain the degree of:

Master in Air Transport Operations

November 2025

DEFINITIVE VERSION

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ISEC LISBOA | INSTITUTO SUPERIOR DE EDUCAÇÃO E CIÊNCIAS

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ACKNOWLEDGEMENTS

The conclusion of this dissertation represents not only the culmination of an academic endeavour, but also a process of personal growth and perseverance. This journey was characterised by numerous challenges, in particular the demanding task of reconciling the expectations I set for myself with the responsibilities of my professional career. Nevertheless, this has proved to be an important contribution to my personal and professional development. This work would not have been possible without the support of many individuals, to whom I consider important to extend my gratitude.

To my advisors, who were true sources of guidance and learning, and which proved to be an essential part of this process. Their precise direction was crucial for this work to take shape and achieve the quality I aimed. I am especially grateful for their availability and their contributions that enabled me to transform initial ideas into a structured study with academic rigour. Without their support, the development of this project to its present standard would not have been possible.

I also wish to acknowledge my family, whose support and understanding made the development of this academic journey easier. I am especially grateful to my girlfriend and my mother for the patience and encouragement they offered me throughout this journey.

Finally, my gratitude also goes to my aviation colleagues, who actively contributed to this study.

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ABSTRACT

This study examines how different crew rostering policies influence flight crew performance. Using a resource-based framework, this work conceptualizes crew rostering policies as resource passageways that provide flight crew with varying levels of access to psychological resources while offering differential protection against resource depletion, which consequently affects their performance.

Specifically, this research hypothesizes that three crew rostering policies - traditional rostering, simple preferential bidding, and advanced preferential bidding - function as resource passageways that differ in the autonomy and inclusion they provide to crew members.

Furthermore, this work proposes that these differences should affect flight crew's dedication levels and fatigue and, consequently, their safety behaviours performance (i.e., in-role, extra-role, and upward safety communication). Results from two complementary studies support our predictions. Study 1 employed a vignette experiment with 160 flight crew members to demonstrate that the three crew rostering policies differ in the autonomy and inclusion they afford, with these differences associated with enhanced dedication and reduced fatigue. Study 2 used a one-month time-lagged panel design with 221 flight crew members to corroborate these initial findings and extend them by showing that the autonomy and inclusion provided by different crew rostering policies influence safety behaviours through their effects on dedication and fatigue.

KEYWORDS

FLIGHT CREW, CREW ROSTERING, SAFETY BEHAVIOURS, RESOURCES

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RESUMO

Este estudo investiga de que forma diferentes políticas de pedidos de atividades (i.e., *bidding*) nos planeamentos dos tripulantes de aviação influenciam os comportamentos de seguranças destes. Com base numa abordagem baseada em recursos, conceptualizamos as políticas de pedidos como vias de acesso a recursos, o que por consequência conferem às tripulações diferentes níveis de acesso a recursos psicológicos, enquanto proporcionam diferentes níveis de proteção contra o esgotamento desses recursos, o que, por sua vez, afeta o seu desempenho.

Especificamente, propomos que três tipos diferentes de políticas de pedido de atividades – *rostering*, *simple preferential bidding* e *advance preferential bidding* – funcionam como vias de acesso a recursos que variam na autonomia e inclusão proporcionadas aos tripulantes. Adicionalmente, propomos que estas diferenças influenciam os níveis de dedicação e fadiga e, consequentemente, o seu desempenho em comportamentos de segurança.

Os resultados dos dois estudos realizados sustentam as nossas hipóteses. No primeiro estudo, com uma amostra 160 tripulantes (i.e., pilotos e tripulantes de cabine), demonstrámos que as três diferentes políticas de pedidos diferem entre si relativamente à autonomia e inclusão que proporcionam, estando estas diferenças associadas a um maior nível de dedicação e a uma redução de fadiga. O segundo estudo, baseado num modelo longitudinal com intervalo temporal de um mês, que envolveu 221 tripulantes, corroborou e aprofundou as conclusões iniciais, revelando que a autonomia e a inclusão decorrentes das diferentes políticas de pedidos influenciam os comportamentos de segurança através dos seus efeitos na dedicação e na fadiga.

PALAVRAS-CHAVE

TRIPULANTES, CREW ROSTERING, COMPORTAMENTOS DE SEGURANÇA, RECURSOS

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RESUMO ALARGADO

Introdução

As companhias aéreas comerciais operam num meio altamente competitivo e volátil, onde a consistência do desempenho operacional é essencial para assegurar a qualidade do serviço e a estabilidade financeira. Um dos fatores cruciais característicos desta complexidade operacional encontra-se na gestão estratégica de recursos humanos, que representa, após o combustível, a segunda maior despesa operacional.

No âmbito da gestão de recursos humanos, o planeamento de tripulações (*crew scheduling),* constitui uma das funções mais críticas de qualquer companhia aérea. Esta refere-se ao processo de desenvolvimento e atribuição de trabalho aos tripulantes de voo. Ao contrário de outras indústrias, este processo altamente complexo exige um equilíbrio de um certo número de requisitos como regulamentação, acordos coletivos de trabalho e eventualmente preferências individuais dos tripulantes na criação dos seus planeamentos.

Devido à sua complexidade, o processo de planeamento é frequentemente dividido em duas fases: *pairing* e *rostering.* Numa primeira etapa, são criadas um conjunto de setores de voo (chamados *pairings),* que posteriormente são atribuídos aos tripulantes de forma a compor as suas escalas mensais. Este processo composto por duas fases é geralmente designado na literatura como *crew scheduling problem.*

A investigação nesta área tem geralmente focado essencialmente na otimização operacional, centrando-se no desenvolvimento de modelos matemáticos sofisticados concebidos para minimizar custos e maximizar a eficiência da utilização dos tripulantes.

Mais recentemente, investigadores começaram a reconhecer que os efeitos dos planeamentos dos tripulantes transcendem a mera eficiência operacional e redução de custos, abrangendo também implicações comportamentais como consequência deste processo. Este facto deu origem a um crescimento na investigação dos efeitos dos planeamentos nos tripulantes.

Todavia, a investigação existente, explorou a superfície dos efeitos dos planeamentos nos comportamentos organizacionais dos tripulantes. Estudos publicados demonstram como o processo de planeamento influencia a fadiga dos tripulantes. Apesar de não se menosprezar as contribuições destas investigações, existe na investigação académica uma lacuna: a compreensão da relação entre a capacidade que os tripulantes têm de influenciar o seu planeamento mensal e os seus comportamentos.

A forma como os tripulantes conseguem influenciar o processo de atribuição de voos permanece largamente inexplorado. Adicionalmente, importa realçar, que existem diversas políticas de atribuição de voos, que variam entre si no grau em que permitem a participação dos tripulantes na criação da sua escala mensal.

Responder a esta questão tem o potencial de fazer avançar a investigação académica neste processo de atribuição de voos, bem como, conferir considerações importantes, que permitem formular recomendações de gestão baseados em factos empíricos sobre como as práticas de gestão de recursos humanos influenciam a segurança e a estabilidade operacional. Este avanço é particularmente crítico num setor em que o erro humano pode ter consequências catastróficas.

Neste sentido, este estudo procura colmatar as lacunas acima identificadas, investigando como diferentes políticas de pedidos de atividades nas escalas dos tripulantes afetam o desempenho destes. Mais especificamente, este trabalho, formula e testa um modelo que relaciona estas diferentes políticas com os comportamentos de segurança dos tripulantes.

A atenção deste trabalho recai sobre os comportamentos de segurança por constituírem um elemento crucial da função dos tripulantes de voo. Adicionalmente, ao comparar múltiplas políticas de pedidos, este estudo providência provas empíricas sobre os seus efeitos no desempenho dos tripulantes de voo.

Enquadramento Teórico

O planeamento e atribuição de trabalho (*personnel scheduling and rostering)* diz respeito ao processo de construção e atribuição de trabalho para o quadro de colaboradores de uma organização, de forma a garantir que esta consegue fornecer os seus bens e/ou serviços de forma eficaz. Contudo, este processo não é simples, uma vez que envolve diversas restrições que variam de setor para setor, com cada indústria a apresentar um conjunto próprio de condicionantes e particularidades.

É reconhecido a extrema dificuldade no desenvolvimento e atribuição de trabalho, em que simultaneamente, se tenta distribuir trabalho de forma justa e equitativa, se respeite todas as normas laborais em vigor e ao mesmo tempo se tente atender às preferências individuas de cada trabalhador. Apesar da considerável complexidade deste processo, as organizações não devem subestimar a sua importância, já que este processo pode influenciar significativamente, de forma positiva ou negativa, o desempenho organizacional.

No setor dos transportes, os desafios relacionais com planeamento e atribuição de trabalho, verificam-se em diversos domínios, incluindo transportes de mercadorias, serviços de transporte público e nos serviços de transporte aéreo. Contudo, o planeamento de tripulações no setor da aviação, tem merecido maior atenção académica, devido à relevância e impacto económico que gera.

A natureza fundamental do planeamento de tripulações consiste em alinhar, de uma forma eficiente, pessoal qualificado com as suas respetivas funções, tem em conta eventuais restrições operacionais, requisitos legais e objetivos organizacionais. Tudo isto enquanto se tenta minimizar custos laborais e, ao mesmo tempo, maximizar a qualidade de vida dos trabalhadores. Como consequência, as companhias aéreas enfrentam a difícil tarefa de desenvolver a atribuir atividades laborais de uma forma que se alinhe com os seus objetivos estratégicos e a sua posição competitiva no mercado (e.g., crescimento e redução de custos operacionais).

O processo de planeamento dos tripulantes reflete essa complexidade ao abordar, de cada vez, dois problemas distintos: *pairing* e *rostering.* Numa primeira fase, procura-se resolver a problemática do *crew pairing.* Nessa fase, os voos são agrupados para formar períodos de serviço de trabalho (*duties*). Posteriormente, esses períodos de trabalho são combinados para formar os *pairings,* que são uma sequência de voo, com uma duração de um ou mais dias, com o começo e término na base do tripulante. O planeamento de um tripulante é constituído por múltiplos *pairings*, que são atribuídos ao tripulante na construção do seu planeamento mensal, designada de *rostering*.

O *crew rostering* consiste no processo na combinação de vários *pairings* com outras atividades (e.g., férias, treino) e atribuí-los individualmente a cada tripulante. Enquando o *pairing* tem como foco principal minimizar custos operacionais, o *rostering* aborda um conjunto distinto de desafios operacionais.

Na literatura académica são descritas várias abordagens para atribuir trabalho às tripulações: *bidline, rostering* e *personalized roster*. A principal diferença destas abordagens reside na capacidade que é conferida ao tripulante de efetuar pedidos de *pairings* específicos, folgas e outras atividades, e por consequência influenciar o seu planeamento mensal.

As preferências dos tripulantes são recolhidas através de um processo designado por *bidding*. Um *bid,* corresponde a uma preferência, que pode ir desde a uma seleção de um *pairing* específico, um período de folgas, até à possibilidade de evitar determinados destinos. Estas ferramentas de recolha de preferências estão incorporadas na abordagem do *personalized roster* e o sistema é conhecido como *Preferential Bidding System.* O objetivo deste sistema é de criar um planeamento mensal personalizado de acordo com as preferências e necessidades do tripulante.

A capacidade que um tripulante tem de efetuar pedidos, varia em função de dois fatores: a abordagem de *rostering* adotada pela companhia aérea e as políticas especificas de pedidos que são implementas na empresa. Isto é, uma empresa que utilize uma abordagem de *rostering,* não permite que tripulante efetue qualquer tipo de pedido, o que o impossibilita de ter controlo sobre o seu planeamento e expressar eventuais preferências. Por outro lado, uma empresa que utilize uma abordagem de *personalized rostering,* que permite ao tripulante expressar preferências, pode ter implementada uma política mais restritiva que só permita ao tripulante, por exemplo, efetuar um pedido de um *pairing* específico.

Os fornecedores de softwares de pedidos disponibilizam diferentes módulos, cada um com as suas particularidades, que diferem essencialmente na forma como os pedidos por ser expressos e também alocados. A amplitude e sofisticação das preferências, varia em função da política de pedidos implementada pela companhia aérea. Alguns sistemas permitem pedidos mais simples, como dias de folga ou determinados *pairings.* Outros, possibilitam pedidos mais complexos, como a possibilidade de evitar certos horários de apresentação, evitar certos destinos, preferências por rotações que permitam ao tripulante dormir em casa, entre outras.

Este estudo foca-se em duas das abordagens mencionadas, *rostering* e *personalized rostering*, por representarem os métodos mais utilizados pelas companhias aéreas. Dado que o *personalized rostering* abrange várias políticas no processo de pedidos, mais especificamente a amplitude de pedidos que os tripulantes têm à disposição, esta investigação analisa duas políticas de pedidos implementados na indústria: um sistema de pedidos simples (*simple PBS*) e um sistema de pedidos mais avançado (*advanced PBS*).

A principal diferença entre estas duas políticas de pedidos reside na amplitude de pedidos conferida ao tripulante. Isto é, o sistema de pedidos mais simples, restringe ao tripulante escolha de *pairings* e/ou dias de folgas. Já o sistema mais avançado de pedidos, expande estas opções, permitindo um leque mais extenso de pedidos, como prioritizar ou evitar certos destinos, definir horários preferenciais de apresentação de início ou término de trabalho, entre outros, resultando num planeamento mais personalizado.

Argumenta-se que estas três abordagens estudadas (*rostering*, *simple PBS* e *advanced PBS*), captam a diversidade estratégica existente das companhias aéreas na atribuição de trabalho aos seus tripulantes. Ao expandir o tipo de pedidos disponíveis, estas políticas de PBS, procuram proporcionar aos tripulantes uma experiência de um planeamento mais personalizado, ajustado às preferências e necessidades individuais, com o objetivo de melhorar a qualidade de vida dos tripulantes, aumentar a eficiência operacional e reduzir os custos operacionais das companhias aéreas.

Descrição do Problema e Objetivos da investigação

Este estudo partiu principalmente, mas não só, de uma brecha na literatura académica. A complexa problemática de *airline scheduling* partia da enraizada vontade da indústria de minimizar custos operacionais e maximizar a eficiência dos trabalhadores. O grande objetivo deste trabalho é de alguma forma redirecionar o foco da literatura existente nas margens operacionais e dos lucros para a importância estratégica dos trabalhadores.

A singularidade única dos profissionais da aviação motivou este trabalho de pesquisa. A realidade é que esta força trabalhadora é bastante destinta das demais. Existem condições especificas que não te aplicam a estes, bem como estão sujeitos a situações que outras indústrias não estão.

O tradicional horário das 9h-17h não se aplica neste domínio, bem como outras características laborais que podem beneficiar estes trabalhadores (e.g., trabalho remoto). Como tal, este estudo pretende dar a conhecer, a forma como estes trabalhadores podem influenciar os seus horários de trabalho e a forma como é normalmente, possível fazê-lo: através de sistemas de pedidos.

Conforme mencionado, as companhias aéreas utilizam diferentes sistemas de alocação de trabalho (i.e., *rostering*), de acordo com as suas necessidades e objetivos estratégicos. Uma das principais diferenças entre eles é a possibilidade e a forma como um tripulante consegue manipular o seu mês de trabalho. Da mesma forma que outras indústrias, estes trabalhadores têm também uma vida pessoal, necessidades e interesses, pelo que a possibilidade de pedirem um dia de folga para um familiar ou preferência por um determinado destino/horário por razões fisiológicas pode eventualmente carecer-lhes de vantagens comportamentais.

Todavia, estas suposições não passam de teoria, pelo que, o impacto da participação de tripulantes da aviação no seu planeamento mensal, carece de validação empírica.

Como tal, o nosso estudo representa o primeiro estudo empírico a investigar como é que diferentes políticas de pedidos em diferentes sistemas de planeamento afetam os comportamentos de segurança destes.

Principais Contribuições

Os resultados deste estudo oferecem perspetivas significativas, tanto do ponto de vista teórico como do ponto de vista prático. Do ponto de vista empírico, verificou-se que a adoção de sistemas de pedidos está influencia o comportamento dos tripulantes. Mais precisamente, quando mais permissível o sistema de pedidos maior a perceção de autonomia do tripulante bem como maior a sua perceção de inclusão no processo de decisão. Esses recursos adicionais conferidos ao tripulante, refletem-se ainda em níveis de fadiga mais baixos e um aumento de nível de dedicação.

Importa ainda salientar que o nosso estudo não foca apenas no resultado individual, mas também nas repercussões que estes recursos têm na segurança operacional. Este estudo comprovou que tripulantes menos fatigados e mais dedicados, demonstram comportamentos de segurança melhorados, com adesão rigorosa aos procedimentos operacionais e exibindo uma atitude mais proativa nos procedimentos de segurança das suas empresas.

Do ponto de vista teórico, este trabalho aprofunda a aplicação dos modelos JD-R e COR na indústria da aviação. Os resultados corroboram ambos os modelos, ao demonstrar que o aumento de recursos (i.e., autonomia e inclusão), pode atenuar os efeitos das exigências inerentes da função de tripulante (i.e., fadiga) e simultaneamente fomentar fatores psicossociais (i.e., dedicação). Adicionalmente, este estudo alinha-se com a teoria da Conservação de Recursos, na medida em que demonstra que ao oferecer recursos ao trabalhador, ajuda-os a conservar recursos pessoais, evitando perdas que resultariam em fadiga. Desta forma, os tripulantes conseguem canalizar os seus recursos para comportamentos benéficos, como seguir e contribuir com as práticas de segurança.

Em termos práticos, os resultados deste estudo fornecem dados para as companhias aéreas e reguladores. Ao investirem em sistemas de planeamento que permitam ao tripulante influenciar a construção da sua escala (através de pedidos), os tripulantes registam um aumento nos seus níveis de dedicação e uma redução no seu nível de fadiga, enquanto reforça, a cultura de segurança da empresa. Dessa forma, é criado um ganho mútuo para o funcionário e para a organização.

Principais Conclusões e Perspetivas de Investigação Futuras

A investigação que propusemos corrobora o nosso objetivo. Isto é, o sistema avançado de PBS está associado a menores níveis de fadiga e níveis de dedicação mais elevados. Noutras palavras, quanto mais restritivo o sistema de pedidos for, mais fadiga o tripulante sente e menos dedicado.

Estes resultados seguem a tendência da nossa premissa apresentada. Ou seja, quanto mais um tripulante consegue customizar o seu planeamento mensal menos fadiga ele apresenta e mais dedicado se encontra. Eventualmente, a longo prazo, estes resultados podem também levar a uma redução no absenteísmo, uma vez que um tripulante que se encontra menos fatigado tem uma menor probabilidade de colocar baixa.

Por fim, o estudo propôs-se a verificar a relação entre os sistemas de pedidos e os comportamentos de segurança dos tripulantes. A expectativa inicial do trabalho era que estes não afetavam os comportamentos de segurança *in-role* nem *extra-role* uma vez que os protocolos de procedimentos operacionais estão bem enraizados na indústria, e dizem respeito a uma responsabilidade essencial do tripulante.

Conforme mencionado, os resultados suportam parcialmente certas hipóteses mediadas relativamente aos comportamentos de segurança, o que revela que os procedimentos operacionais se mantêm intactos às variações de sistemas de pedidos, conferindo uma contribuição importante à robustez dos protocolos de segurança na indústria da aviação.

Este trabalho pretendia demonstrar a importância de atribuir aos tripulantes ferramentas para desempenharem as suas funções. Mais concretamente, a possibilidade de contribuírem ativamente para o seu planeamento mensal de trabalho. O foco deste estudo passava também por dar dados tangíveis, e demonstrar às companhias aéreas o benefício mútuo que existe em implementar sistemas avançados de *PBS*.

Adicionalmente, os reguladores de aviação, que têm um papel fundamental na indústria da aviação, podem aproveitar estes resultados para sugerir linhas gerais de implementação destes sistemas a companhias que ainda não os possuem, ou, aquelas que possuem um sistema mais básico.

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ABBREVIATIONS AND ACRONYMS

COR – Conservation of Resources theory

EASA – European Union Aviation Safety Agency

IATA – International Air Transport Association

ICAO – International Civil Aviation Organization

JD-R – Job Demands-Resource model

FWA – Flexible Working Arrangements

WFC – Work Family Conflict

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DEFINITIONS

Bidding – Refers to the process by which airline crew members request or express their preferences for work schedules, pairings, destinations, days off, and other roster-related criteria.

Bidline – A predefined monthly roster offered to flight crew members. It consists of a set sequence of flights, reserve days, off-days, and ground duties, published in advance, which crew members can select, or bid based on their seniority.

Crew Scheduling – Problem of assigning a group of workers to a set of tasks.

Duty period – Period of time between reporting for an assignment and being release from that assignment.

Flight leg – A flight leg is defined as the journey from take-off to landing.

Flight time limitations – Refer to a regulatory framework that governs the maximum allowable working hours and minimum required rest periods for flight crew members, with the objective of preventing fatigue and ensuring operational safety in commercial aviation.

Ground Duties – Ground duties refer to all non-flying, but mandatory, professional activities assigned to flight crew members, typically scheduled during off-flight periods. These include simulator training, recurrent training, and other operational or regulatory sessions required to maintain licensing, proficiency, and regulatory compliance.

Pairing – Refers to a sequence of flight legs (segments) that are grouped together to form a work assignment for crew, typically starting and ending at the same crew base.

Qualifications – Required certifications, licenses, training and medical.

Reserves – Crew members who are not assigned to a specific flight but are on standby and must be available to operate a flight if needed, often on short notice.

Roster – A work schedule specifically developed for each individual crew member.

Training – Initial and ongoing training that pilot and cabin crew received to acquire and maintain the skills, knowledge, and certifications necessary to perform their duties.

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1 INTRODUCTION

1.1 GENERAL

As high-reliability organizations, commercial airlines operate within complex systems where consistent operational performance is essential for ensuring service quality and financial stability (Chutima & Arayikanon, 2020). Central to this operational complexity is strategic personnel management, which represents the second-largest operational expense after fuel (International Air Transport Association [IATA], 2024).

Within airlines' personnel management operations, crew scheduling stands as one of the most critical functions of every airline (Novak et al., 2020). It refers to the design and assignment of work schedules to flight crew members - including both cockpit and cabin crew - and, unlike standard workforce coordination, crew rostering requires navigating multiple competing demands simultaneously (Grant et al., 2024). Airlines must balance legal mandates, security regulations, collective bargaining agreements, and individual crew preferences when creating employee work schedules, creating a complex optimization challenge (Azadeh et al., 2013; Quesnel et al., 2020)

Airline managers are aware of the level of reliability needed in their organizations and high volatility and intense competition in the industry (Chutima & Arayikanon, 2020). Yet, the process of assigning an optimal crew schedule is anything but simple.

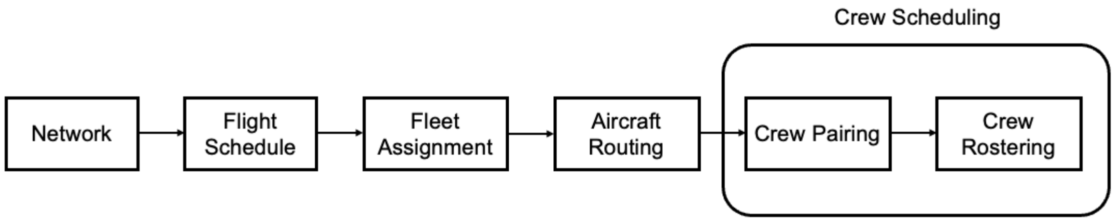

Figure 1: Overview of the airline planning process
Source: Korte & Yorke-Smith (2025, p. 2)

Due to is complexity, the scheduling process is often divided in two stages: crew pairing and crew rostering (i.e., assignment) (Kasirzadeh et al., 2017). Airlines first produce a set of flight legs (pairings), which are subsequently assigned to crew members to create a monthly schedule (Wen, 2024). This dual-stage process is often-called crew scheduling problem amongst literature (Maenhout & Vanhoucke, 2011) and has always generated substantial scholarly interest.

Early research efforts were mainly concerned with operational optimization and focused on developing sophisticated mathematical models designed to minimize costs while maximizing crew utilization efficiency (e.g., Achour et al., 2007; Gamache et al., 1998; Kohl & Karisch, 2004; Lučic & Teodorovic, 1999; Medard & Sawhney, 2007). More recently, scholars have begun to recognize that the effects of crew scheduling extends beyond cost efficiency and also encompass broader implications namely for flight crew members who experience these scheduling decisions directly (Quesnel et al., 2020). This recognition has sparked an emerging research stream examining how crew scheduling affects individual employees (Badánik et al., 2021; Lee & Kim, 2018; Lin et al., 2024; Novak et al., 2020).

The effectiveness of the scheduling process is not solely gained by minimizing airlines' operational costs (Kohl & Karisch, 2004), but also to the extent they positively affect aircrew organizational behaviours (e.g., Badánik et al., 2021; Lin et al., 2024; Novak et al., 2020). This line of research puts the individual as its main focus, and acknowledges that different scheduling systems, and specifically its characteristics (e.g., the options they confer to aircrews), may affect aircrew behaviours and performance differently (e.g., Lee & Kim, 2018; Lin et al., 2024).

Consequently, it becomes more relevant to emphasize the critical importance of satisfying flight crews individual preferences within the scheduling process (Wen, 2024). Crew members choices are treated as central psychological factors that must be acknowledged, mainly because their monthly work schedules profoundly shape their personal lives (Wen, 2024).

Yet, the surface is only being scratched of the true effects of scheduling on crew organizational behaviours (Lee & Kim, 2018; Lin et al., 2024). Existing research has demonstrated how crew scheduling process (Badánik et al., 2021; Lin et al., 2024; Wang et al., 2023) influence fatigue among flight crew. Moreover, Chen & Chen (2014) have explored the relationship between JD-R and cabin crew safety behaviours. While these investigations have made valuable contributions to the field, there remains a gap in understanding the causal relationship between flight crew's empowerment on their schedule and subsequent behaviours.

Whereas this emerging perspective has expanded crew scheduling literature beyond its early operational and institutional focus, research in this domain remains in its infancy (Lin et al., 2024). Specifically, two critical aspects warrant further investigation. First, existing research has predominantly examined crew scheduling's effects on flight crews' health and well-being indicators, such as fatigue and sleep patterns (Badánik et al., 2021; Lin et al., 2024; Wang et al., 2023). However, the influence of crew rostering (i.e., the assignment of work) policies on flight crew behaviour and performance remains largely unexplored (Lin et al., 2024). This oversight limits both our theoretical and empirical understanding of the true effects of this key personnel management operation (Chutima & Arayikanon, 2020).

Second, crew rostering policies differ considerably in the degree to which they accommodate employee input, with some systems allowing extensive crew member participation in setting monthly schedule preferences while others maintain centralized, management-driven scheduling approaches with minimal employee autonomy. Despite widespread recognition that airlines adopt distinct rostering policies (Quesnel et al., 2020), to the best of our knowledge no empirical study has systematically examined how these different approaches affect flight crew performance. This work argues that this limits our understanding of rostering policies' comparative effectiveness.

Addressing this issue has the potential of advancing the scholarly field of crew rostering beyond operational efficiency considerations, and it would enable evidence-based managerial recommendations about how personnel management practices affect safety and operational reliability (Grant et al., 2024; Quesnel et al., 2020). Such insights are particularly critical in an industry where human error can have catastrophic consequences (Pasha & Stokes, 2018).

Accordingly, this study addresses the aforementioned gaps by examining how different crew rostering policies affect flight crew performance. Specifically, this work theorizes and test a model that links crew rostering policies to flight crew safety behaviours, moving beyond traditional health and well-being indicators to examine behavioural and performance outcomes. This study focuses on safety behaviours because they constitute a core aspect of flight crew jobs (Bendak & Rashid, 2020) and are essential to the operational integrity of commercial aviation (Lin et al., 2024). Moreover, by comparing multiple crew rostering policies, this work provides empirical evidence of their differential effects on flight crew performance.

To achieve this goal, this study builds on recent research in this domain (e.g., Chen & Chen, 2014; Grant et al., 2024) and develop a theoretical framework integrating insights from two resource-based theories: Conservation of Resources (COR) theory (Hobfoll, 2011) and the Job Demands–Resources (JD-R) model (Bakker et al., 2023; Demerouti et al., 2001).

This study makes four primary contributions to the crew rostering literature. First, it contributes to the emerging literature on the individual effects of crew rostering to examine how crew rostering policies affect flight crew behavioural outcomes, specifically safety behaviours. COR theory is used to conceptualize crew rostering policies as organizational resource passageways that differentially affect flight crew access to valued resources, moving beyond previous operational perspectives to focus on psychological mechanisms through which rostering systems influence employee outcomes. Second, the integration of COR theory with the JD-R model enables to untangle the psychological mechanisms – i.e., dedication and fatigue - that link resource caravan passageways (crew rostering policies) with performance outcomes. This theoretical synthesis expands both the JD-R and COR frameworks by demonstrating how specific organizational scheduling factors function as valuable resources that influence employee motivation and job demands, thereby specifying the precise pathways through which rostering policies affect behaviour. Third, this study provides the first systematic empirical comparison of how different crew rostering policies differentially affect flight crew performance outcomes. Finally, from a methodological perspective, this work employs a robust dual-study approach, combining experimental and field research methodologies to provide comprehensive evidence for our theoretical model. This multi-method approach enhances the validity and generalizability of our findings while addressing limitations inherent in single-method studies common in this field.

Resource theories are particularly acknowledged for their predictions about the effect of environmental conditions on individuals' behaviours, motivation and well-being

(Hobfoll et al., 2018). First, this work departs from the resource caravan passageways principle predicted by COR theory suggesting that organizations can create ecological conditions that either foster of limit the creation of resources by individuals (Hobfoll et al., 2018). As it will elaborated later, this study argues that different scheduling systems enact distinct levels of job resources, namely autonomy and inclusion. Second, the COR theory suggests that individuals endowed with greater resources are more motivated at work and are more likely to experience favourable health outcomes (Hobfoll et al., 2018).

This work elaborates on these two mechanisms by theorizing under the JD-R model (Bakker et al., 2023). Specifically, this study suggests that people endowed with more job resources (i.e., autonomy and inclusion in decision making (IDM) should experience less fatigue and increase work dedication. Finally, this work posits that this should affect aircrews' safety behaviours. This research argues that aircrews who perceived greater autonomy and inclusion in the scheduling system of their organization should be more likely to engage in safety behaviours (both in-role and extra-role) due to the experience of less fatigue and great work dedication. Figure 2 depicts this study's research model.

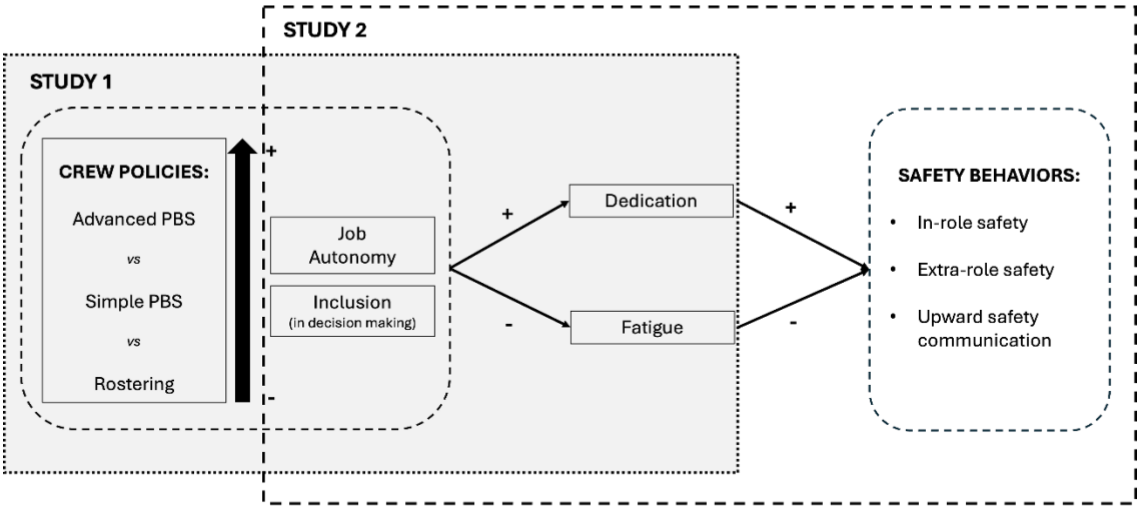

Figure 2: Research model
Source: Own Elaboration

1.2 SCOPE

While this emerging perspective on rostering having expanded the literature of crew scheduling beyond the early operational and institutional considerations, research in this domain remains in its infancy (Lin et al., 2024). This research stream has predominantly focused on examining the effects of crew rostering on flight crews' health and well-being indicators (e.g., fatigue; sleep patterns; Badánik et al., 2021; Lin et al., 2024; Wang et al., 2023). The influence of crew rostering on flight crew behavior and performance remains largely unexplored, obscuring its broader organizational implications (Chutima & Arayikanon, 2020).

This study aims to deepen understanding of how different bidding policies (i.e., the ability to influence flight crew's monthly schedule) affect the performance of cockpit and cabin employees (hereafter, flight crew) by theorizing and testing a model that links different rostering approaches to their safety behaviours.

This work focuses on safety behaviours because they constitute a core aspect of flight crew jobs (Bendak & Rashid, 2020; Kandera et al., 2019) and are essential to the operational integrity of commercial aviation (Lin et al., 2024). Building on recent research in this domain (e.g., Chen & Chen, 2014; Grant et al., 2024), this research developed a theoretical framework integrating insights from Conservation of Resources (COR) theory (Hobfoll, 2011) and the Job Demands–Resources (JD-R) model (Bakker et al., 2023; Demerouti et al., 2001).

The central assumption of resource theories is that individuals' performance is affected by the resource pool individuals have at their disposal. Drawing on the caravan passageways principle from COR theory, which suggests that organizations shape ecological conditions that either enable or restrict employees' access to valued resources (Hobfoll et al., 2018), this study argue that different crew rostering systems - rostering, simple preferential bidding, and advanced preferential bidding - serve as resource caravan passageways that vary in the degree of autonomy and inclusion in decision-making they afford employees.

Furthermore, this work proposes that rostering systems perceived as promoting employees autonomy and inclusion in decision-making (i.e., preferential bidding) should endow individuals to acquire additional resources and resisting resource depletion (Hobfoll et al., 2018). Drawing on the JD-R model this work specifies that should experience motivation and lower job demands (Bakker et al., 2023), which this study operationalizes as increased dedication and reduced fatigue, respectively. Finally, this work posits that these processes ultimately shape flight crew safety behaviours. Specifically, when flight crew perceive greater autonomy and inclusion in the rostering system, they are more likely to engage in safety behaviours - including in-role, extra-role, and upward safety communication - because they feel more dedicated and less fatigued

1.3 MOTIVATION

This thesis departs from the notion that further research about the behavioural implications of flight crew rostering systems is warranted, in order to expand knowledge about the effects that different bidding policies have on aircrews. It is important to stress that the specific characteristics of flight crew job - e.g., long duty periods, unpredictable work hours (Lin et al., 2024) – poses particular challenges that are not captured on research studying employees' organizational behaviour in traditional jobs and organizations.

This distinctive nature of aviation professionals served as key driver for this research. In contrast to many other professions, the working lives of flight crew members are shaped by a unique set of factors. Their schedules are not only irregular, but are also closely governed by strict safety standards, regulatory requirements, and operational demands. Accordingly, it becomes imperative to examine mechanisms that may afford flight crew members protection against their high job demands. This study seeks to address a gap in the literature by exploring the effect of such available mechanisms on flight crew behaviours.

Moreover, advancing knowledge in this regard also brings important implications for managers by providing insights about how to effectively maximize crew's performance and utilization. Flight crew performance is tied to the way they are treated and managed by the organization (Sarwar & Muhammad, 2021; Xiu et al., 2019), and has a direct influence on the value proposition an airline offers to the customers it seeks to retain (Novak et al., 2020).

Finally, our research opens room for managerial recommendations to aid airline managers to properly adjust their scheduling systems in order to provide to aircrew the necessary resources to perform safety behaviour.

1.4 OBJECT AND OBJECTIVES

As mentioned, most of academic literature regarding aircrew scheduling, focuses on a more macroeconomic view with the goal of minimizing costs and optimizing allocation of duty to these professionals (Azadeh et al., 2013; Deveci & Demirel, 2018b, 2018a; Wen, 2024).

In addition, and, to the best of our knowledge, there seems to be a lack of studies analysing the impact of different rostering approaches affect flight crews' behaviours. Therefore, our aim, is to examine in which way how these different rostering approaches may affect flight crew, and the mechanisms underlying this relationship. Specifically, our project aims to:

1) To determine whether different rostering systems are associated with different levels of autonomy and inclusion in decision making;
2) To assess whether different rostering systems are associated with different levels of fatigue and dedication;
3) Establish a relationship between different rostering systems and aircrew's safety behaviours.

More specifically, this work argues that a system that allows flight crew ability to state their preferences for flying (i.e., destinations, days-off, days of flights, etc.) influences positively aircrews safety behaviours. From the available rostering systems presented and studied, it is believed that an Advanced Preferential Bidding System (PBS), is the scheduling system that allows flight crew to have more autonomy and inclusion in decision making over their flying schedule.

To achieve what this study proposes, two studies have been developed. Study 1 (S1) will work as a starting point for study 2 (S2), i.e., the variables from S1 will serve as mediators of S2. Moreover, S2 will expand the findings of S1 by testing the mediating role of S1's variables in the relationship between PBS and safety behaviours. Consequently, the following hypotheses were developed:

Hypothesis 1: Advanced preferential bidding policy is associated with higher levels of autonomy (H1a) and inclusion in decision making (H1b) than rostering and simple preferential bidding.

Hypothesis 2: Advanced preferential bidding policies are associated with lower levels of fatigue (H2a) and higher levels of dedication (H2b) than traditional rostering and simple preferential bidding policies.

Hypothesis 3: Autonomy perceived from scheduling policies is positively associated with in-role safety behaviour, extra-role safety behaviour, and upward safety communication via reduced fatigue (H3a) and increased dedication (H3b).

Hypothesis 4: Inclusion perceived from scheduling policies is positively associated with in-role safety behaviour, extra-role safety behaviour, and upward safety communication via reduced fatigue (H4a) and increased dedication (H4b).

This study makes the following contributions. First, this work allowed to contribute to the crew rostering literature by integrating COR theory with the JD-R model to conceptualize rostering systems as organizational resource passageways that differentially affect flight crew access to valued resources. This theoretical framework moves beyond previous operational perspectives to specify the psychological mechanisms through which rostering systems influence employee outcomes.

Moreover, this research aims to expand the JD-R and COR framework by focusing on specific organizational factors, specifically demonstrate how the ability to influence monthly rosters trough preferential bidding systems can act as a valuable resource and a job-demand moderator.

Second, this work further contribute by shifting focus from traditional health outcomes to examine safety behaviours as key performance indicators, addressing calls for more comprehensive understanding of rostering's behavioural consequences (C.-F. Chen & Chen, 2014).

Finally, this research employs a dual-study approach combining experimental and field research to provide robust evidence for our theoretical model. This multi-method approach enhances the validity and generalizability of our findings while addressing limitations inherent in single-method studies common in this domain.

1.5 METHODOLOGY

This project entails two quantitative studies to test our hypotheses. In study 1, a vignette experimental study, a sample of 160 aircrews was used to test if different scheduling systems – one rostering system and two bidding system options - are associated with different levels of autonomy and inclusion in decision making. Also, this work tested whether these systems affect aircrews' fatigue and job dedication.

In study 2, a time-lag panel design was used and followed a sample of 221 aircrew over one month period. The purpose of this study was to demonstrate external validity to Study 1 and extend its findings, by exploring the resources generated by the airlines' scheduling system affect air crew safety behaviours (i.e., in-role, extra-role, and upward safety communication).

1.6 WORK STRUCTURE

This dissertation is organized into five main chapters. Themes and organisation of these chapters can be summarized as follows:

Chapter 1 lays the groundwork for our project by exploring the context, defining our research boundaries, and highlighting our focus. This opening chapter presents a brief contextualization of the problematic with a brief analysis of the problem being addressed, the objectives that guide the research and the strategic approach developed to address the identified problematic. The chapter ends with a comprehensive roadmap of the thesis structure, orienting readers to the content of the subsequent chapters.

Chapter 2 provides a comprehensive survey of academic literature, beginning with an exploration of personal scheduling strategies and their application and problematic in diverse work contexts. This is followed by an analysis of aviation scheduling systems, focusing on their operational complexities and human factor integrations. We then investigate methodologies for expressing individual preferences in work context and the reason some may not be suitable for aviation professionals. Theoretical foundations are finally established through a critical examination of JD-R theory's insights into resource allocations and COR theory's explanations.

Chapter 3 outlines the research methodology, including the reasoning for employing the dual study approach, as well as sample characteristics and data collection methods.

Chapter 4 reports and discusses the findings from both studies, highlighting theoretical and managerial implications.

Chapter 5 concludes the study by summarizing the key contributions, acknowledging limitations, and offering recommendations for future research and industry practises.

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2 LITERATURE REVIEW

2.1 PERSONNEL SCHEDULING AND ROSTERING

Personnel scheduling and rostering is known as the process of constructing work timetables for an organization's staff to ensure they can deliver their goods and/or services effectively (Ernst et al., 2004). However, this process is far from straightforward, as it involves numerous constraints that varies from industry to industry, with each sector having its unique set (Ernst et al., 2004).

The challenge around developing work schedules is widespread across multiple industries (Dorne, 2008), as an optimised shift is a crucial tool for maximizing the efficient use of an organization's resources (Dorne, 2008; Van den Bergh et al., 2013). It's extremely challenging to find an optimal solution for allocating work to employees that minimizes operational costs, distributes shifts fairly, meets employees' preferences and satisfies all workplace constraints (Ernst et al., 2004).

Despite the considerable complexity involved in personnel scheduling, organisations should not underestimate its importance, as it can significantly influence (positively or negatively) organisational performance and potentially affect costumer perceptions as well (Dorne, 2008).

The organizational process of constructing, and respectively allocating, a work timetable to an employee has a long tradition within the organization and operations management scholarship (e.g., Topaloglu & Ozkarahan, 2004; Van den Bergh et al., 2013; Wittmer et al., 2015).

In the early years, the interest on this subject was especially motivated by the organizations' interest in balancing the utility of their workforce with decreasing operational costs (Ernst et al., 2004). This phenomenon has been studied on several organizational contexts and forms of employment (Silvestro & Silvestro, 2000; Van den Bergh et al., 2013), as well as in the aviation industry (Deveci & Demirel, 2018a; Isabelle Kinnunen, 2015; Maenhout & Vanhoucke, 2010).

While aviation remains our main focus for investigating the effects of rostering on flight crew, valuable insights can be also drawn from other high-reliability industries such as healthcare, emergency services, and energy production (Enns et al., 2015; Peršolja, 2023). These sectors similarly require continuous operation, high alertness and minimal tolerance for error, often under intense temporal constraints. High-reliability organizations (HROs) in these industries operate in complex, high-risk environments while trying to maintain safety and performance levels (Chassin & Loeb, 2013).

In healthcare, for instance, several research link nurse's work schedule to a range of adverse psychological and physical outcomes (Peršolja, 2023). Evidence indicates that specific nursing schedules are associated with insufficient and poor-quality sleep, and increased fatigue (Geiger-Brown et al., 2012). Despite this evidence, there are mixed results on the association between work schedules and nurse fatigue (Peršolja, 2023). According to Peršolja (2023), this association might depend on specific schedule characteristics rather than shift work itself.

This aligns with the typical schedules that nursing personnel experience, which are typically characterized by irregular working hours and shift work patterns, associated with their job high demands (Enns et al., 2015). Suggestions for mitigating the consequences of such demanding schedules may involve giving employees greater autonomy and control over their working schedules (Turunen et al., 2022).

Recently, there has been a growing emphasis on satisfying employees' needs during the scheduling allocation process (e.g., part-time, preferences for a specific shift, specific days off) (Van den Bergh et al., 2013). These added considerations of employees' preferences and individuals needs further complicates an already complex rostering task.

According with the literature (Dorne, 2008; Ernst et al., 2004; Van den Bergh et al., 2013), the process of allocating rosters to employees can be distinguished in three main phases: staffing, roster design and roster allocation (Dorne, 2008). Staffing is the process of forecasting future workload into the necessary resources to achieve the required service demands (Dorne, 2008). Roster design focuses on developing and creation of a work schedule, while roster allocation focal point is on assigning employees the previous created schedule (Dorne, 2008).

Figure 3: Process overview of scheduling process
Source: Dorne (2008)

2.2 THE AIRLINE SCHEDULING PROBLEM

In the transportation sector, crew scheduling challenges are prevalent across multiple domains including public transportation services such as bus and rail operations, freight transportation via trucks and railways, as well as both cargo and passenger services in air transportation (Barnhart et al., 2003). However, airline scheduling has garnered significantly more academic interest, primarily due to its substantial economic significance and broader impact (Ernst et al., 2004).

Ernst et al. (2004, p. 5), proposed a general framework for personnel scheduling, structured into six sequential modules. Figure 3 illustrates how this framework aligns with the airline crew scheduling process. For the purposes of this thesis, our research focus will be on roster allocation process (i.e., crew rostering).

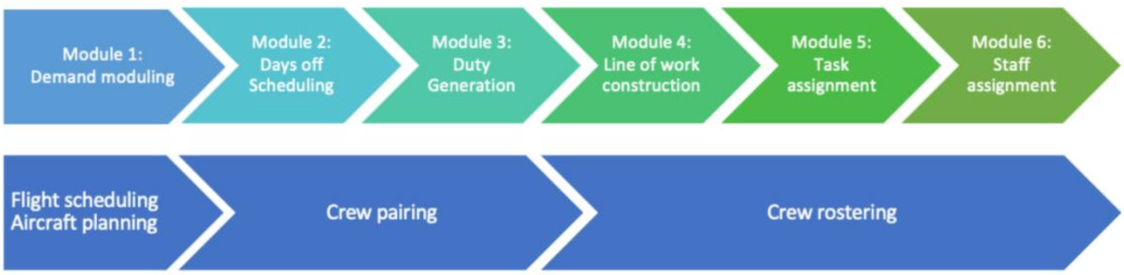

Figure 4: Modular analysis of airline crew scheduling compared with Ernst et al. (2004) scheduling process
Source: Meskanen (2024, p. 18)

The airline scheduling process consists in the allocation of available resources in alignment with projected passenger demand (de Armas et al., 2017). This process encompasses multiple interdependent decisions involving fleet assignment, aircraft routing, and crew scheduling, all of which must be coordinated to achieve both profitability and operational efficiency (Korte & Yorke-Smith, 2025).

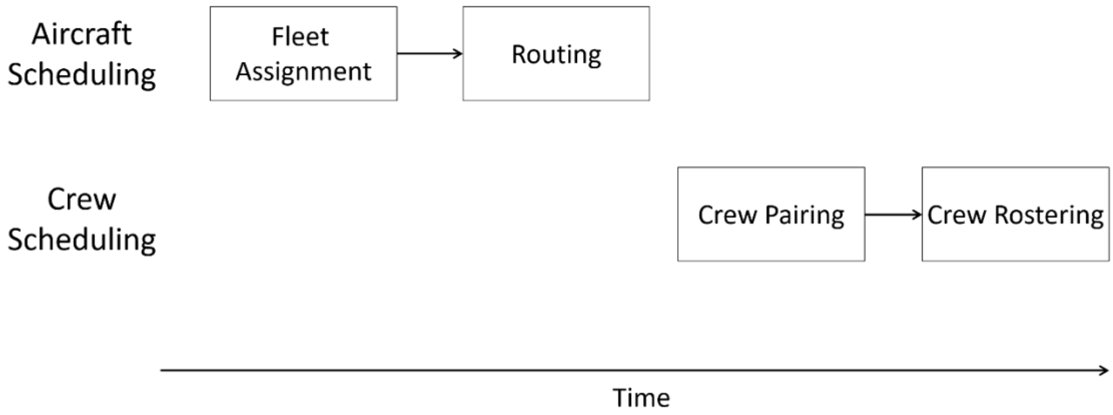

Figure 5: Airline scheduling process
Source: de Armas et al. (2017)

The fundamental nature of crew scheduling focuses on optimally matching qualified personnel to required duties while considering various operational constraints, regulatory requirements, and organizational objectives (Barnhart et al., 2003). All of these, while trying to minimize labour costs and maximizing the perceived life quality of employees (Maenhout & Vanhoucke, 2011).

Yet, the stressful nature of the jobs in the aviation industry, especially for aircrew jobs, poses unique challenges for airlines' managers. Airlines are considered high-reliability organizations (Dekker & Woods, 2010; O'Neil & Krane, 2012; Roberts, 1990) because failure in their operations is likely to result in costly and unacceptable outcomes. Thus, their operations are more complex than more error tolerant organizations (O'Neil & Krane, 2012).

Thus, airlines face the complex and crucial task of developing and allocating work to their employees while trying to balance their strategic objectives and competitive position (i.e., growth, minimizing operational costs) (Barnhart, 2009; Korte & Yorke-Smith, 2025).

The volatile nature of airlines operations, characterized by frequent disruptions, demands also robust scheduling systems that can also adapt to changing circumstances while preserving crew satisfaction and operational effectiveness. Research has demonstrated that crew-related disruptions have cascading effects on airlines operations (Chung et al., 2017). Furthermore, airlines are increasingly recognizing how this scheduling processes affects their workforce (Nurmi et al., 2023) and ultimately influence the airline's distribution of service and goods and overall competitive positioning (Novak et al., 2020).

The aircrew crew scheduling process captures this complexity by addressing two main problems: pairing and rostering (work assignment) (Gamache et al., 1998; Kohl & Karisch, 2004; Medard & Sawhney, 2007).

2.2.1 CREW PAIRING

In the first place, attention is drawn on solving the crew pairing problem (Barnhart, 2009; Kohl & Karisch, 2004; Nissen & Haase, 2006). Flights are a grouped together to form duty periods, which are series of sequential flights legs comprising a day's work for a crew (Barnhart et al., 2003). Duties are then strung together to form pairings, which are a sequence of flight legs, with a duration of one or more days, that start and end at the crew's home base (Nissen & Haase, 2006). Finally, flight crew's monthly schedules are made of multiple pairings with time off between them. This forms the basis of a crew member's monthly work assignment, in the form of either rosters or bidlines (Kohl & Karisch, 2004; Midkiff et al., 2009).

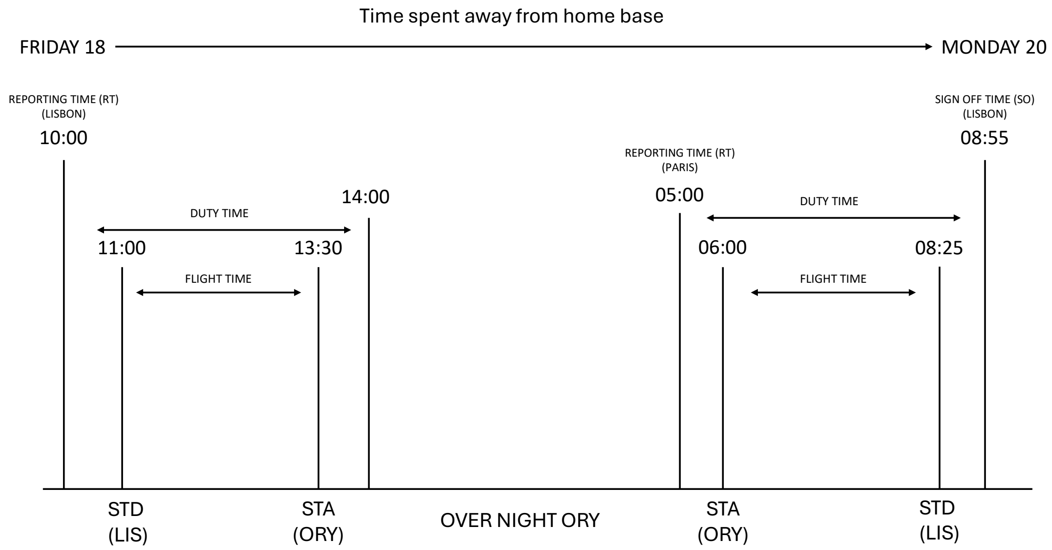

Figure 6: Visual representation of an example of a pairing on a flight from Lisbon (LIS) to Paris-Orly (ORY)
Source: Adapted from Maenhout & Vanhoucke (2011)

Roster is a work schedule specifically developed for each individual crew member, taking into consideration his or her needs (e.g., training) and preferences (e.g., requested days off or/and specific destinations). A bidline, is a generic schedule which is assigned to a crewmember through a bidding and allocation process usually based on seniority (Midkiff et al., 2009).

This process is a complex operational challenge that requires careful consideration of numerous factors (e.g., flight time limitations) (Maenhout & Vanhoucke, 2010). Once pairings are established, they serve as building blocks for construction of crew members monthly schedule (Barnhart, 2009).

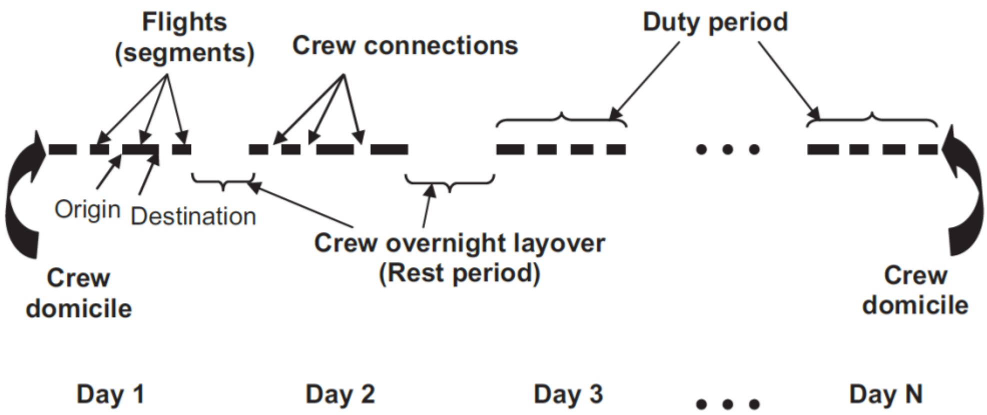

Figure 7: Set of duties grouped in a single pairing
Source: Abdelghany & Abdelghany (2016, p. 15)

2.2.2 CREW ROSTERING

After crew pairing problem is solved, focus is drawn on assigning pairings to flight crew. Crew rostering (assignment) involves combining multiple pairings among other activities (e.g., ground duties, vacations) and assigning them individually to crew members (Abdelghany & Abdelghany, 2016; Barnhart et al., 2003; Kohl & Karisch, 2004).

While crew pairing primarily aims on minimizing operational costs while ensuring all scheduled flights are covered (Wen, 2024), the crew rostering problem addresses a distinct set of organizational challenges (de Armas et al., 2017). The fundamental objective of crew rostering involves the assembly of previously established pairings into monthly schedules (Wen, 2024), that align strategically with the airline's operational priorities and goals (de Armas et al., 2017).

These operational priorities and goals frequently include cost reductions through the minimization of crew assignment costs, such as, avoidance of overtime compensations (de Armas et al., 2017). Additionally, airlines may also prioritize satisfaction levels of crews (Midkiff et al., 2009) or emphasize the equitable distribution of workload among them (Barnhart, 2009; de Armas et al., 2017). These multifaceted objectives illustrate the complex decision-making environment inherent in the crew rostering problem.

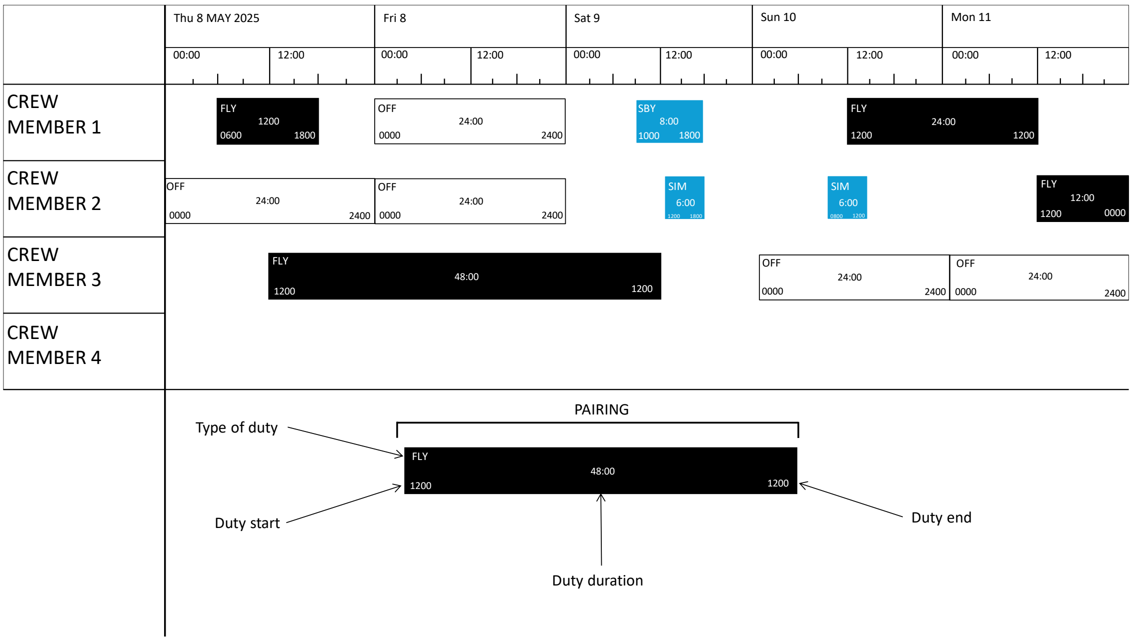

Figure 8: Example of a crew schedule (roster)
Source: Own Elaboration

Figure 8 represents an example of a crew schedule. A set of daily activities, called duties, which are separated by rest periods, forming the foundation of a typical flight crew work schedule (Abdelghany & Abdelghany, 2016; Barnhart, 2009).

Both crew pairing and rostering require strict adherence to regulatory policies and negotiated labour agreements while balancing crew preferences and minimizing operational costs (Midkiff et al., 2009). The complexity of these process stems from the need to account for numerous inputs, such as crew qualifications, ground duties, and mandatory rest periods (Kohl & Karisch, 2004). In addition, and similarly to other industries, some approaches to crew rostering attempt to incorporate personal requests from crew members, aiming to maximize their overall satisfaction levels (Barnhart, 2009).

In the highly competitive airline industry, crew costs make up the second largest expense for airlines, behind fuel costs (Chutima & Arayikanon, 2020; Korte & Yorke-Smith, 2025). Since fuel costs fluctuate based on market conditions and remain largely outside airlines' direct control (Deveci & Demirel, 2018a), management typically concentrates its cost-reduction efforts on workforce scheduling optimization to minimize operational expenses (Wen, 2024) and enhance crew utilization efficiency (Korte & Yorke-Smith, 2025).

Despite that, rosters directly impact crew members by determining their work-life balance, route assignments and rest allocations (Abdelghany & Abdelghany, 2016) and their effects on flight crew should not be underestimated.

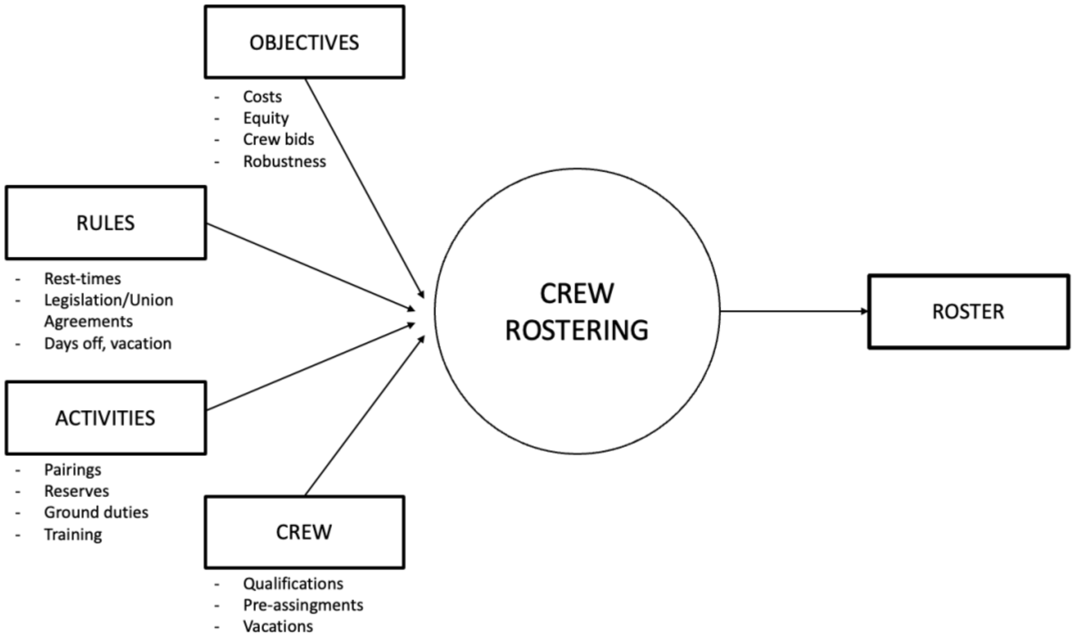

Figure 9: Airline rostering problem and different inputs
Source: Adapted from Kohl & Karisch (2004)

Despite differences in focus, scholarly research on pairing and rostering problems has been guided by a common objective: investigation and advancement of sophisticated algorithmic frameworks designed to address these complex challenges (Chutima & Arayikanon, 2020; Kasirzadeh et al., 2017). However, due to the direct effects of the pairing problem on the airline operations and costs, scholars have devoted considerable attention to this aspect (Gamache et al., 1998; Isabelle Kinnunen, 2015; Lučic & Teodorovic, 1999), leaving the rostering problem comparatively underexplored (Kohl & Karisch, 2004; Maenhout & Vanhoucke, 2010; Medard & Sawhney, 2007).

As already demonstrated by some literature, the exploration of the rostering problem opens the possibility to expand the literature of crew scheduling on aviation industry beyond the cost-benefit perspective to consider the implications of scheduling on airliners crew organizational behaviours (Badánik et al., 2021; Novak et al., 2020). This study is positioned in this particular stream of research.

Due to its complexity scheduling of aircrews is supported by software design to aid airlines in their rostering task. The way crew members preferences are considered (or not) within the scheduling process varies from airline to airline (Isabelle Kinnunen, 2015) for different operational reasons.

Amongst academic literature, in order to allocate work to aircrew, multiple approaches are described: bidline, rostering, personalized roster (Chutima & Arayikanon, 2020; Gamache et al., 1998; Kohl & Karisch, 2004; Meskanen, 2024; Novak et al., 2020; Römer & Mellouli, 2011).

2.2.2.1 Bidline

The bidline policy is a two-stage rostering approach in which airlines first create generic schedules covering all flight pairings without assigning specific crew members. Employees bid for their preferred monthly schedule based on seniority or other criteria, selecting from pre-generated rosters rather than submitting personal requests (de Armas et al., 2017; Gamache et al., 1998).

With this approach, flight crew select a pre-built monthly schedule that matches their preferences (Abdelghany & Abdelghany, 2016). By bidding for a specific pre-built schedule, a crew member has complete visibility into their potential monthly assignments (Kohl & Karisch, 2004).

While this policy provides complete visibility into available assignments (Kohl & Karisch, 2004), it limits employees' capacity to actively shape their work schedules since they must choose from predetermined options.

2.2.2.2 Rostering

In the rostering policy, airline's scheduling department create individualized schedules for each crew member, however it typically limits their ability to submit personal requests, such as specific days off or desired activities (de Armas et al., 2017). Changes are possible, however only through swaps among coworkers.

A variation of this model, known as fixed rostering, uses predetermined patterns of working and off days that remain constant over time (Maenhout & Vanhoucke, 2011;

Meskanen, 2024). This method is commonly employed by some low-cost carriers, providing crew members with predictable routines - such as five days on, followed by four days off (Efthymiou et al., 2021). This scheduling predictability is highly valued by Ryanair pilots, who report that it provides them with a greater sense of control over their professional lives (Efthymiou et al., 2021).

2.2.2.3 Personalized Rostering

Personalized rostering policy incorporates individual crew preferences prior the generation of their monthly work schedules. Crew members' preferences are collected through a bidding process, where employees submit specific requests including particular pairings, rest periods, or destination avoidances and likings (Achour et al., 2007; de Armas et al., 2017; Gamache et al., 1998). Although the final roster outcome is often uncertain due to airlines' need to fulfill operational demands (Abdelghany & Abdelghany, 2016; Badánik et al., 2021; Gamache et al., 1998; Kohl & Karisch, 2004), employees' preferences are considered as main inputs.

This approach allows crew members to submit specific personal requests which are taken into account in the generation of individual schedules (Deveci & Demirel, 2018a), allowing crew the ability to influence roster construction (Jeppesen, 2024).

2.3. CREW ROSTERING POLICIES

Aircrew preferences are collected through a feature called bidding (de Armas et al., 2017). A bid indicates a specific preference, that can be a range from a specific pairing, a rest period, avoid certain destinations, etc. (Achour et al., 2007; Gamache et al., 1998). These preference collection and schedule generation tools are known as preferential bidding systems (PBS) (Le Duc & Badánik, 2021). The fundamental objective of PBS is to create optimized, personalized work schedules that better align with employee preferences while meeting operational requirements (Gamache et al., 1998).

The bidding capabilities available to aircrew members vary considerably depending on two key factors: the specific rostering methodology employed by the airline (i.e., bidline or personalized rostering) (Meskanen, 2024) and the particular bidding policies established (Kohl & Karisch, 2004).

Each bidding software provider has different modules with different bidding policies that allow crew members to submit their requests. Each module has their own particularities that differ mainly on how the crew member is allowed to express their requests and how these are allocated (i.e., seniority, system of points) (Jeppesen, 2024).

Jeppesen for instance, offers four bidding models for airlines to choose from: Strict Seniority PBS Points, Strict Seniority PBS Bid Groups, Fair Share PBS and Lifestyle (Jeppesen, 2024). Each module represents a different approach to preference collection and work allocation.

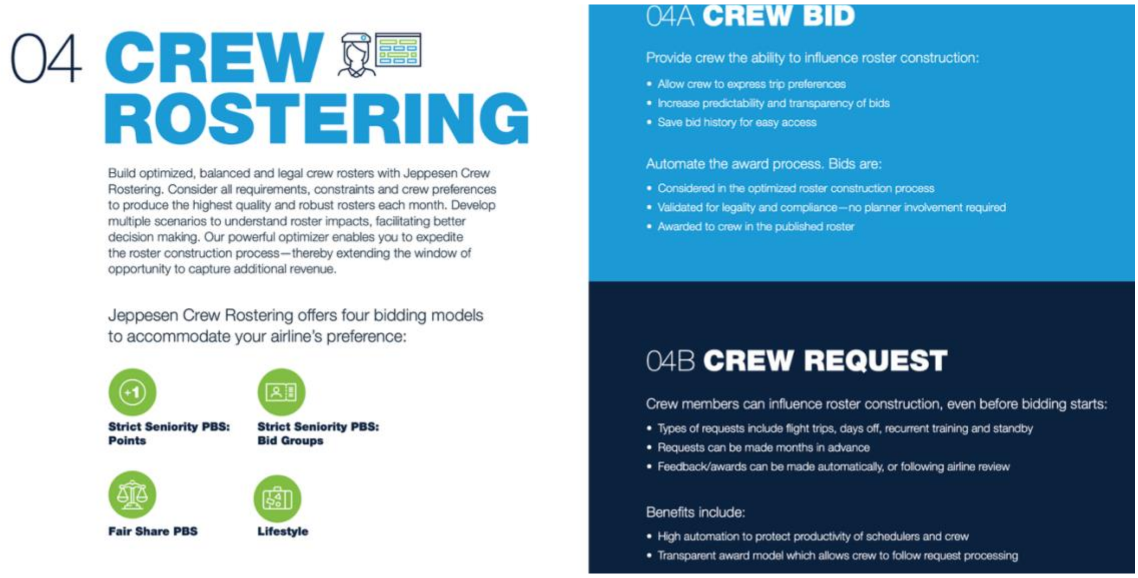

Figure 10: Jeppesen's Crew Rostering different bidding policies
Source: (Jeppesen, 2024)

The range and sophistication of preference expression, varies across preferential bidding policy implemented by the airline (Kohl & Karisch, 2004). Some bidding systems allow straightforward requests such as specific pairings and or day offs. Other, allows crew member to articulate nuanced requests including avoidance of destinations, preferred reporting times, layover preferences, and many more (Jeppesen, 2010, 2019, 2024).

By expanding the scope of allowed requests, these models seek to provide a more personalized scheduling experience for crew members (Jeppesen, 2024), tailored to their likings and specific needs, with the goal of improving crew's quality of life while enhancing operational efficiency and reducing airline's costs (Navblue, 2024).

This study focuses on two of the aforementioned approaches - rostering and personalized rostering – because they capture the predominant crew rostering methods employed by contemporary commercial airlines. Although the bidline system holds historical importance, it fails to accommodate flight crew members ability to influence and shape their work schedule.

Furthermore, given that personalized rostering encompasses various configurations of the bidding process - specifically, the types of requests employees can submit - this study examines two general forms of personalized rostering policy commonly implemented across commercial airlines: simple preferential bidding, and advanced preferential bidding.

The main difference between these two approaches lies in the scope of requests available to crew members. Simple bidding restricts requests to fundamental scheduling elements: days off and pairing assignments. In contrast, advance bidding expands beyond these basic options to enable a broader range of requests, such as the ability to prioritize or avoid certain destinations, specify preferred sign-on and sign-off times and many other, which should result in a more customized schedule.

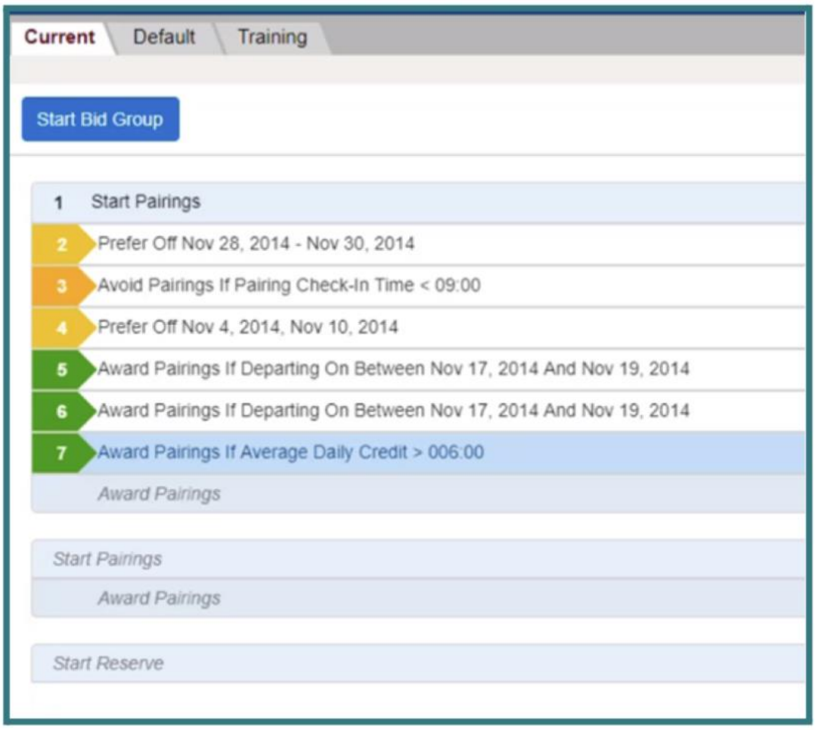

Figure 11: Example of an advanced PBS
Source: (Navblue, 2024)

Collectively, this work argues that these three crew rostering processes (rostering, simple preferential bidding, and advanced preferential bidding) capture the strategic diversity of contemporary airline scheduling approaches and provide a comprehensive framework for understanding current industry practices. Table 1 summarizes the three crew systems targeted in this study.

Table 1 summarizes the three crew systems targeted in this study.

Table 1: Bidding differences between studied crew rostering approaches
Source: Own Elaboration

	Rostering	Personalized Rostering	
		Simple PBS	**Advanced PBS**
Bidding	Not allowed; schedules are fully developed by rostering	Allowed	Allowed
Type of Bid	N/A	Simple: only days off and/or specific pairings	Advanced: Broader requests possible, such as avoiding certain destinations, preferred check-in times, and other scheduling preferences
Number of Bids	None	Limited to a fixed predefined number	Variable based on weight and prioritization
Sources	(de Armas et al., 2017; Deveci & Demirel, 2018a; Gamache et al., 1998)	(Deveci & Demirel, 2018a; Gamache et al., 1998; Jeppesen, 2019, 2024; Le Duc & Badánik, 2021)	(Deveci & Demirel, 2018a; Jeppesen, 2019, 2024; Kohl & Karisch, 2004; Navblue, 2024)

Note. This table demonstrates the ability a crew member has to express their requests and consequently influence their monthly roster on two of approaches (Rostering and Personalized Rostering) mentioned on this paper.

2.4. EMPLOYEE'S WORK SCHEDULE PREFERENCES

Organizations face the complex challenge of harmonizing the company's strategic objectives with the personal needs of their workforce. This act requires management to carefully take into account several employee factors including capability, schedule availability and work preferences, while simultaneously optimizing labour expenses and maintain quality standards. Since organizations typically seek to control expenses and meet staffing requirements (Ernst et al., 2004), they may underestimate the hidden costs and potential consequences that may arise when employee schedules preferences are disregarded (Holtom et al., 2002).

The fundamental rationale for adopting these policies stems from their perceived effectiveness in mitigating work-family conflict (WFC) and their potential to enhance work-life balance (Allen et al., 2013). This addresses a challenge where a significant number of professionals struggle to balance work and personal responsibilities, resulting in time constraints that adversely affect their health, overall wellbeing, job performance and organizational commitment (Kelly & Moen, 2007). Time is a precious resource and maintaining an equilibrium between home and work not only fosters emotional and physical well-being but also contributes for business success (Cooper, 2005).

Research has proven that having control over various aspects of one's job reduces the risks of various physiological and psychological illness (Fenwick & Tausig, 2001). Morrow et al. (1994), for instance, has supported the argument that employees whose work schedule reflects their preferences have more positive work-related attitudes and work commitment. Holtom et al. (2002) has also found evidence that when employee preferences in scheduling are met, employees are likely to be more satisfied with their jobs, more committed to the organization and to exhibit better performance on the job. A common limitation upon these studies seems to be that focus has been given to the implications of control rather than variability in employee control (Masso, 2013).

Work status congruence refers to the degree to which an employee's work arrangement matches their preferences. Specifically, it measures the extent to which people are working full-time, part-time, or on contract by choice rather than by circumstance (Loughlin & Murray, 2013). When employees work in a status that matches their preferences (e.g., working full-time because they want to work full-time, or working part-time because they prefer part time), they have high work status congruence. Conversely, when there's a mismatch between preferred and actual work status, employees experience work status incongruence (Burke, 2004).

Using this congruency perspective, researchers suggest that employees are more satisfied with their work-like balance when they work in a status, schedule, shift, and hours they personally prefer (Holtom et al., 2002). These findings, however, examine conventional work shifts and patterns (Holtom et al., 2002; Loughlin & Murray, 2013), which offer limited applicability to aviation professionals whose irregular duty cycles, circadian disruptions, and variable rest periods fundamentally differ from traditional occupations.

Consequently, the work status congruence framework requires recontextualization to address the unique operational constraints of aviation work environment, particularly regarding the industry specific scheduling systems and the mechanism through which flight crews can express and realize their work arrangements preferences.

2.4.1. FLEXIBLE WORKING ARRANGEMENTS

Among one of the growing areas on influencing how work is allocated to individuals is Flexible Work Arrangements (FWA). FWA are defined as *"employer provided benefits that permit employees some level of control over when and where they work outside of the standard workday"* (McNall et al., 2009, p. 62). These arrangements offer employees the autonomy to decide when an/or where work is completed, thereby allowing them to decide the allocation of their time, attention and energy across different domains (i.e., work, family personal life) (Allen et al., 2013).

Flexible Working Arrangements have been widely implemented by businesses across the world (Pavlova, 2019) due to their assumed positive effects on employees' performance and well-being. Such practises have also been considered as strategic in order to attract, retain and motive key talent (Allen et al., 2013). Nonetheless, scholarly knowledge in this field has yielded mixed results, with some studies finding support for a positive influence of FWA on worker's physical and mental health (De Menezes & Kelliher, 2017; Halpern, 2005) while others find no significant effects (Joyce et al., 2010). This suggests that more research is needed, especially with more robust design able to establish causality (de Menezes & Kelliher, 2011; De Menezes & Kelliher, 2017; Onken-Menke et al., 2018).

Besides focusing on individuals' behaviours, academic research has also highlighted the importance of these measures for organizations. Antunes et al. (2023), for instance, has shown how labour flexibility policies have been valuable for improving organizations competitive advantage.

Flexible working arrangements include a set of policies that enable employees to modify the temporal and spatial dimension of their work, including flexitime (adjustable start/end times), flexplace (remote work options), reduced hours, or compressed work weeks (Allen et al., 2013; Anderson & Kelliher, 2009). These practises are broadly categorized into two dimensions: flexitime, which grants employees control over their daily work schedules within predetermined parameters, and flexplace, which pertains to work location (Shifrin & Michel, 2021).

A critical analysis of these arrangements reveals inherent limitations, particularly in the specific case of flight crew. Flexitime policies typically allow employees to select work start and end times, provided that they complete a predetermined number of working hours (Jeffrey Hill et al., 2008). Flight crews, however, face specific limitations. While they may exercise some control over when they begin work, they typically have minimal influence over the duration of their workdays.

Similarly, flexplace arrangements, which allows workers to select where they perform work-related duties (Jeffrey Hill et al., 2008), seems to be inapplicable to pilots and cabin crew. Remote working, for instance, does not apply to a pilot or cabin crew, positions which still need a physical presence on their place of work. These distinctive occupational characteristics create challenges when attempting to apply conventional flexible work arrangements policies to flight crew.

This aligns with Allen et al. (2013), who emphasizes that not all forms of flexibility produce the same level of control. Besides that, Kelly & Moen (2007), show some limitations of FWA, arguing that flexible work policies can be allocated in ways that limit employees' control over when and where they work. These insights accentuate the complexities of applying FWAs across different professions and contexts.

Most research on FWA seems to methodologically focus on specific workers, such as women and parents, who are presumed to benefit most from such policies (Fenwick & Tausig, 2001). Studies highlight how FWAs can help resolve work-family conflicts and improve mental well-being for working families by offering greater autonomy over work schedules (McNall et al., 2009; Russell et al., 2009). Moreover, in certain countries, legislation explicitly frames flexible work as a provision primarily intended for workers with family-related needs (Diário da República, 2025; Fair Work, 2025; Gov UK, 2025).

This work advocates that all workers, regardless of their personal circumstances or reasons, would benefit from having a schedule tailored to their individual preferences. Thus, by moving beyond the assumption that FWAs primarily serve specific groups, organizations could benefit by accommodating the varied needs of their workforce.

Furthermore, research on FWA has emphasized the importance of investigating how varying degrees on employee choice regarding their work schedules affect their outcomes (de Menezes & Kelliher, 2011).

2.4.2. Work Schedule Control

Research has demonstrated that employees in positions with specific job characteristics have reduced access to various flexible work scheduling options (Golden, 2005; Swanberg et al., 2005). This disparity has prompted scholars to explore alternative conceptualizations of workplace flexibility, leading to the recognition of worker schedule control as a distinct concept from the traditional flexible work arrangement concept (Swanberg et al., 2011).

This comes in line with Kelly and Moen (2007) limitations regarding the efficiency of FWA policies. In essence, flexible work arrangements offer employees predetermined flexibility options, whereas work schedule control grants individuals more autonomy and decision-making power over when and how they work (Kelly & Moen, 2007; Swanberg et al., 2011).

Kelly & Moen (2007, p. 491) propose a concept of schedule control which is defined as *"the ability to determine when one works, where one works, and perhaps how many hours one works".* This concept is based on the job demands-control model (Kain & Jex, 2010; Kelly &

Moen, 2007; Masso, 2013), but focuses on control over where and when work is done rather than how work is done (Kelly & Moen, 2007; Swanberg et al., 2011).

According with the job demands-control model, employees experience the most psychological and physical symptoms when confronted with high job demands while simultaneously having minimal control over how their work is performed (Kain & Jex, 2010; Kelly & Moen, 2007). Thus, following this theoretical framework, is reasonable to propose that increased control over work scheduling might serve as a buffer, potentially mitigating the negative psychological and physiological consequences associated with high-demand occupations (Kain & Jex, 2010).

However, additional empirical investigation is necessary to establish and understand this relationship. Furthermore, following Kelly and Moen (2007) recommendation, this work focuses our research on investigating the effects of potential benefits of schedule control for both employees and organizations within a high work demand-context – specifically, flight crew operations.

Lack of schedule control has been found to have significant, negative relationships with lack of work-home balance and conflict between work and home (N. J. Beutell, 2010; Fenwick & Tausig, 2001). Moreover, N. J. Beutell (2010), N. Beutell and O'Hare (2018) have found similar results, concluding that schedule control reduce work interfering with family (WIF) and increase work-family synergy (WFS). Schedule control was also significantly associated with greater job satisfaction and lower turnover intentions (Brossoit et al., 2020).

Similarly to research on flexible policies, this line of thought seems to me somehow identical, when studies seem to have tended to focus on workers who may be more vulnerable (i.e., parents) to specific job demands. Consistent with our earlier argument, this work claims that having control over one's schedule could benefit all employees (Fenwick & Tausig, 2001).

Despite positive findings in our research amongst available literature, this study have identified several definitions of schedule control that may not adequately capture the scheduling complexities unique to flight crews. Schieman and Young (2010, p. 1393) for instance, argues that *"schedule control entails the degree to which workers have control of the start and/or finish times of workers".*

This definition, with its narrow focus on temporal boundaries, proves insufficient for comprehensively measuring scheduling control among flight crews. Our research aims to understand the broader implications of allowing flight crews to influence their schedules through various options, rather than focusing exclusively on temporal work parameters (i.e., start and/or finish duty times).

2.4.3. AUTONOMY AND DECISION MAKING

While schedule control shares conceptual and empirical overlap with broader constructs such as job autonomy and decision-making, it is distinguished by its specific focus on temporal aspects of work. Job autonomy and decision-making typically encompass a wider range of work-related freedoms. In contrast, schedule control has a more narrowly defined, pertaining specifically to an individual's ability to determine the temporal parameters of their work activities (Schieman & Young, 2010).

Swanberg et al. (2011) argues, on their research, that schedule control acts as a form of autonomy, which could influence employees' satisfaction regarding their schedule. Autonomy seems to be a broader concept that encompasses multiple dimensions of workplace freedom and decision-making authority (Nie et al., 2023).

Furthermore, research has encouraged future studies to explore different ways, on different contexts, in which employees can exercise control and autonomy over their schedules (Antunes et al., 2023; French et al., 2024) and if this posits benefits, or not, to both employees and organizations (Kelly & Moen, 2007).

Autonomy has been subject of academic research due to its acknowledged influence on employees' outcomes (De Spiegelaere et al., 2016). This concept dates back to research as old as Hackman and Lawler (1971), which provided evidence that job characteristics could directly affect employees' attitudes and behaviour at work. Further research by Hackman and Oldham (1976) resulted in the development of the Job Characteristics Model, which systematizes the relationship between job characteristics and individual responses to work.

This model recognizes autonomy as key work characteristics that influences positively personal and work-related outcomes (Hackman & Oldham, 1976). The importance of autonomy has been further elaborated through subsequent models, including the Job-Demands Control (Karasek & Theorell, 1990) and the Job-Demands Resources model (Bakker & Demerouti, 2007). These models underscore autonomy's capacity to trigger motivational processes that promote positive employee outcomes, reinforcing its critical role in organizational behaviour research (De Spiegelaere et al., 2016).

While having been widely acknowledged as an important asset in workplace literature for decades, research have conceptualized job autonomy in numerous distinct way (Breaugh, 1999). Hackman and Oldham (1976, p. 258) have defined job autonomy as *"the degree to which the jobs provide substantial freedom, independence, and discretion to the individual in scheduling the work and in determining the procedures to be used in carrying it out"*. Subsequent research has emphasized the necessity and value of distinguishing between different faces of autonomy (Breaugh, 1985), rather than assessing it as a single, global construct.

In result, three facets were defined: Work Method Autonomy which refers to the degree of discretion/choice individuals have regarding the procedures (methods) they utilize in going about their work, Work Scheduling Autonomy, which refers to the extent to which workers feel they can control the scheduling/sequencing/timing of their work activities and Work Criteria Autonomy, which refers to the degree to which works have the ability to modify or choose the criteria used for evaluating their performance (Breaugh, 1985).

However, since most of these proposed facets of autonomy were developed during the 1980s, recent changes in the workplace environment may inadequately addressed by these conceptual frameworks of job autonomy (De Spiegelaere et al., 2016).

De Spiegelaere et al. (2016) expanded the traditional conceptualization of job autonomy by proposing a four-dimensional framework. While retaining the original dimensions of method and scheduling autonomy, they refined the concept by differentiating work criteria into a more specific dimension called work time autonomy – the discretion employees have regarding when to start and finish work. Additionally, they introduced locational autonomy, which refers to employees' discretion in determining where to perform their work. This expanded framework to better address the modern aspects of work arrangements.

In previous research, autonomy has typically been evaluated as a unified concept, without distinguishing between its various dimensions (Parker et al., 2014; Stiglbauer & Kovacs, 2018). However, examining these distinct faces individually provides greater clarity regarding their impact on work outcomes (Bipp & Walczok, 2024). Thus, while this work acknowledges the subtle conceptual variations between these constructs, for the purposes of this research, job autonomy was considered to be characterized by high decision latitude and control over the work schedule (Dettmers & Bredehöft, 2020).

While these dimensions of autonomy were anticipated to influence work outcomes, researchers did not expect any variations in their relative effects (Humphrey et al., 2007; Stiglbauer & Kovacs, 2018). De Spiegelaere et al. (2016), for instance, found no significant effect of work scheduling autonomy on either work engagement (WE) or innovative work behaviour (IWB). On the other hand, Theurer et al. (2018), found significant support that higher levels of scheduling autonomy were associated with higher levels of IWB. Additionally, Bipp and Walczok (2024), have found that work scheduling autonomy has a paradoxical effect, by not only fostering but potentially also lowering work engagement due to intensification of work.

This paradoxical relationship highlights a gap in our understanding of workplace dynamics. This contradictory effect suggests also that contextual factors may influence how autonomy impacts different work environments. Furthermore, research suggests that autonomy's beneficial outcomes are dependent not only on the specific facet of autonomy, but also on how it interacts with broader workplace characteristics and demands (Kubicek et al., 2017).

This creates a compelling opportunity for further research, particularly within specialized workforces such as flight crews, where unique operational constraints and responsibilities may alter the typical autonomy-outcome relationship.

2.5. CREW ROSTERING POLICIES AS CARAVAN PASSAGEWAYS

Flight crew work represents a unique occupational context characterized by exceptional demands that create intense resource depletion patterns (Grant et al., 2024). Their jobs are acknowledged for their stressful nature because these employees operate within high degrees of mission reliability while pressured to exhibit low error rates (O'Neil & Krane, 2012).

This demanding work architecture requires crew members to continuously mobilize personal and organizational resources including physical energy, cognitive capacity, emotional reserves, social support, and temporal autonomy to sustain performance and cope with occupational stressors. Critically, this creates a constant cycle of resource depletion and replenishment that fundamentally shapes how flight crew experience their work environment and respond to occupational challenges (Grant et al., 2024) .

This resource-dependent nature of flight crew work has led researchers to increasingly adopt resource theories as theoretical lenses for understanding employee behaviour and performance in aviation contexts. Conservation of Resources (COR) theory provides a particularly robust framework, positing that individuals strive to obtain, retain, and protect valued resources, experiencing stress when resources are threatened, lost, or inadequately replenished (Hobfoll et al., 2018).

What makes COR theory particularly relevant is its recognition that resources exist within ecological systems where organizational structures and policies do not merely influence but actively determine the levels of resources individuals can access and maintain (Bakker et al., 2023; Hobfoll et al., 2018). In the aviation industry, crew members' ability to influence their work schedules emerges as a fundamental resource that cascades into other critical resources including work-life balance, schedule predictability, and psychological well-being (Lučić & Teodorović, 2007; Wen, 2024) . Research consistently demonstrates that organizations facilitating crew access to adequate resource pools enable more effective performance and reduced burnout (Efthymiou et al., 2021; Grant et al., 2024).

Resource theories have been fundamental in the organization scholarship to explain employees' behaviour, motivation and well-being (Hobfoll et al., 2018), including in the aviation industry (e.g., Grant et al., 2024). Despite their differences, their underlying assumption assumes that individuals possess limited resources that affect their actions and well-being, and the organizational conditions play a direct role in determining the levels of resources individuals possess.

This resource-centred understanding leads us to reconceptualize crew rostering policies as more than administrative procedures; they represent what COR theory terms "caravan passageways". These refer to organizational mechanisms that *"support, foster, enrich, and protect the resources of individuals, families, and organizations, or that detract, undermine, obstruct, or impoverish people's resource reservoirs"* (Doane et al., 2012, p. 304) . Rostering policies function as institutional passageways that create resource corridors, fundamentally shaping crew members' resource ecologies and determining whether their work environment becomes resource enriching or depleting.

Thus, crew rostering policies on airlines can be accounted as a contextual condition, because its application relies on the decisions of the organization that have a direct influence on employees' outcomes (Grant et al., 2024; Isabelle Kinnunen, 2015). Prior research, in the aviation industry, has indeed stressed the importance of organizations to create conditions that endow these individuals with adequate levels of resources to perform their jobs (Efthymiou et al., 2021; Vulturius et al., 2024).

Individuals actively seek valuable workplace resources such as autonomy, social connections, and performance feedback. These job resources serve as a dual purpose: they facilitate the achievement of work-related objectives and foster personal growth, learning and development. Consequently, job resources set in motion a motivational process that can lead to positive organizational outcomes (Salanova, 2010).

The manifestation of these passageways takes two distinct forms. Facilitative passageways emerge when rostering policies incorporate flexibility mechanisms such as bidding systems for preferred routes, advance schedule notification, or swap opportunities that enable crew members to align work demands with personal resource management strategies. These policies create resource enriching corridors that support schedule predictability, work-life integration, and autonomous decision making. In stark contrast, constrained passageways manifest through rigid rostering systems that impose unpredictable schedules, last-minute changes, or limited crew input, creating resource depleting corridors that force crew members into reactive resource management patterns. Such constraints can precipitate resource spirals where schedule unpredictability undermines sleep quality, family relationships, and personal well-being, ultimately compromising job performance and organizational outcomes.

Based on the description of the three scheduling systems outlined in the previous section, this study suspects that they may vary on the levels of job resources they provide to air crew. Job resources refer to the physical, psychological, social, or organizational aspects of the job that are functional in achieving work goals, reducing job demands and the associated physiological and psychological cost and stimulate personal growth, learning, and development (Bakker et al., 2014).

2.6. THE ROLE OF AUTONOMY AND INCLUSION IN DECISION-MAKING

Building on this caravan passageways framework, this study contends that the three crew rostering policies examined in this study - rostering, simple preferential bidding, and advanced preferential bidding - function as passageways that vary specifically in their levels of autonomy and inclusion in decision making. These two dimensions serve as the defining characteristics that differentiate how each rostering system creates resource access corridors for flight crew.

Autonomy refers to the control employees have over their schedules (Bipp & Walczok, 2024), while inclusion in decision making refers to the degree to which organizations actively seek out and incorporate employees’ diverse perspectives (Nishii, 2013). This work focused on these two job resources for several reasons.

Work scheduling autonomy represents a fundamental passageway characteristic, though workplace research has conceptualized autonomy in various ways over decades (Breaugh, 1999) . The dimension most relevant to crew rostering concerns employees’ perceived control over their work schedules and timing (Bipp & Walczok, 2024; Hackman & Oldham, 1976). Autonomy serves as a defining characteristic of rostering passageways because it constitutes an intrinsic dimension directly tied to job content, reflecting core aspects of job design that determine how much control employees have over their immediate work processes and scheduling environment (Dettmers & Bredehöft, 2020).

The concept of autonomy has garnered substantial attention in organizational research, demonstrating robust associations with numerous employee outcomes (Dettmers & Bredehöft, 2020). Extensive studies have established connections between autonomy and reduced turnover intentions, enhanced job performance, and increased job satisfaction (Breaugh, 1999; De Spiegelaere et al., 2016). This consistent relationship across diverse occupational contexts underscores autonomy's fundamental importance as a job resource (Bakker & Demerouti, 2007).

Further research has revealed that positions characterized by high demands coupled with low autonomy are associated with negative outcomes such as decreased job satisfaction and reduced engagement are also significant predictors of occupational burnout (de Jonge et al., 1999).

The distinctive occupational characteristics of flight crew need a tailored approach to conceptualize and measure job resources. Conventional workplace frameworks may inadequately address the unique operational constraints and demands inherent to aviation professional. This occupational specificity becomes particularly evident when considering flexible work arrangement policies.

Unlike numerous other professionals where FWA such as remoted work represent a viable option (Austin-Egole et al., 2020), flights crews are bound by the necessity of physical presence. Consequently, traditional measurements of workplace flexibility may be problematic in this context. For instance, a flexitime measurement item such as *"I work away from the office for childcare reasons"* (Shockley & Allen, 2012, p. 223), would yield inappropriate or interpretable responses from flight crew due to the nature of their occupation (Breaugh, 1985). Some academic research has also framed some flexibility policies has a form of a job autonomy (De Spiegelaere et al., 2016).

Thus, by focusing on a more specific instrument of work autonomy, tailored for flight crew's job characteristics (i.e., work scheduling autonomy) (Breaugh, 1999), the impact on work outcomes becomes clearer (Bipp & Walczok, 2024). It is thus believed that autonomy is a broader measurement that is suitable to capture flight crews' behaviour outcomes.

Has previously mentioned, academic research has identified decision-making autonomy (i.e., the freedom to make decisions) as a significant dimensions of job autonomy (Humphrey et al., 2007; Karasek et al., 1998; Stiglbauer & Kovacs, 2018).

Inclusion in decision making constitutes a complementary but theoretically distinct dimension that operates at a different organizational level. Unlike autonomy's intrinsic focus on individual job control, inclusion represents an extrinsic dimension that extends beyond task-specific parameters to encompass employees' participation in broader organizational processes and managerial decisions (Stiglbauer & Kovacs, 2018). This dimension aligns with participative decision-making literature, emphasizing managerial philosophies and organizational culture rather than specific job design parameters (Stiglbauer & Kovacs, 2018). While autonomy focuses on individual control over one's own work tasks and immediate environment, inclusion involves being consulted, heard, and considered in decisions that may affect multiple employees or organizational operations (Nishii, 2013).

This study argues that, adopting different rostering policies with different levels of autonomy, ultimately reflects organization-level decisions. Therefore, it is also important to consider extrinsic measures, specifically, the extent to which flight crew members can participate in scheduling decisions as these are strategic and managerial in nature. Including this dimension acknowledges the significant of employee input in shaping work arrangements that directly impact their roles.

Masso (2013) study for instance, found that employee work scheduling is dependent on the extend employees can participate in decision-making. Additionally, participation in decision-making, can increase job satisfaction and organizational commitment (Ohana et al., 2013). Thus, this work assumes, that allowing crew members to participate on the scheduling problem, through bidding, shall be seen as a value-enhanced proposition (Nishii, 2013) which should mutually benefit both employees and organization.

So, given the specific nature of their job, this study proposes that autonomy and inclusion in scheduling decisions – through systems that take into consideration personal requests – should be view has critical job resources that may contribute to their sense of control (Morgeson et al., 2005) and involvement in their work (Ohana et al., 2013).

To elaborate on why different scheduling systems should produce different levels of autonomy and inclusion, this work draws on the tenets of the COR theory (Hobfoll et al., 2018). The theory posits that individuals possess a limit amount of resources and environment conditions should be able to replenish or dimmish individuals resource pool. Important to our theorizing is the corollary of the COR theory about resource passageways, which refers to the *"environmental conditions that support, foster, enrich, and* *protect the resources of individuals, sections or segments of workers, and organizations in total, or that detract, undermine, obstruct, or impoverish people's or group's resource reservoirs"* (Hobfoll, 2011, p. 119). This study argue that scheduling systems can be conceptualized as resource passageways (Hobfoll et al., 2018) and, depending on their technical characteristics, they may create corridors to facilitate or hinder employees' ability to preserve and build their resources, namely autonomy and inclusion.

When compared the characteristics of the three scheduling systems outlined in the previous section, one can argue that advanced PBS should be the one that confers more autonomy and inclusion to aircrews, when compared with rostering and simple PBS. Research has shown that roster characteristics and bidding ability significantly influence crew members satisfaction, functioning as both motivational and hygiene factors (Badánik et al., 2021; Meskanen, 2024; Vulturius et al., 2024).

Within rostering, crew members personal requests are not taken into consideration when building crews monthly schedule (de Armas et al., 2017). This means that there is no way of an individual to request a specific day off in advance or a specific pairing. Crew members have no control on their schedule, which, in theory, gives no sort of autonomy neither inclusion on the process of decision making.

On the other hand, simple and advanced PBS, only differ by having distinct types bidding policies (Kohl & Karisch, 2004). By having a narrower bidding policy, simple PBS, crew members express their preferences by requesting only a pairing and/or day off. On the other hand, advanced PBS has a wider bidding range, allowing, for instance, individuals to express wishes such as morning duties only, or avoiding activities on weekends (Kohl & Karisch, 2004) and combining them all in order to have a monthly schedule more tailored to one's liking. This study argues that advanced PBS should have a higher level of autonomy and inclusion in decision making than the other systems.

These theoretically grounded dimensions create distinct passageway profiles across the three rostering approaches. Rostering operates as a restrictive caravan passageway, providing minimal autonomy and inclusion by building schedules without considering crew preferences, thereby limiting access to schedule control and work-life balance resources (de Armas et al., 2017). Simple preferential bidding functions as a moderately facilitative passageway, offering limited autonomy and inclusion through basic preference expression for specific pairings or days off. Advanced preferential bidding represents a highly facilitative passageway, characterized by extensive autonomy and inclusion features that enable comprehensive preference expression and multiple request combinations, maximizing crew access to organizational resources (Kohl & Karisch, 2004).

2.7. EFFECTS ON FLIGHT CREW LEVELS OF FATIGUE AND DEDICATION

According to COR theory, the ecological conditions provided by resource caravan passageways determine individuals' level of resource acquisition and preservation (Hobfoll et al., 2018). This principle suggests that variations in crew rostering passageway characteristics - specifically, the autonomy and inclusion they provide - should determine the resource levels flight crew can generate and maintain (Hobfoll, 2011). Importantly, COR theory's fundamental tenet posits that the possibility of resource loss is more psychologically impactful than equivalent resource gain, meaning individuals are primarily motivated to prevent resource loss rather than acquire new resources (Hobfoll et al., 2018). Therefore, facilitative caravan passageways should be experienced as both direct resource gain and reduced vulnerability to resource loss, potentially initiating resource gain spirals where additional job resources beget further resource accumulation (C.-F. Chen & Chen, 2014).

To understand how these resource dynamics translate into specific employee outcomes, this work integrates the Job Demands-Resources (JD-R) model, which, while conceptually similar to COR theory (Mansour & Tremblay, 2018), offers a nuanced framework for theorizing how resource availability triggers distinct psychological processes (Bakker & Demerouti, 2024). Although conceptually similar (Mansour & Tremblay, 2018), the JD-R model offers a nuanced framework that posits resources as drivers of subsequent resource acquisition or loss (Bakker & Demerouti, 2024).

The JD-R model predicts that employees' perceptions of resource availability activate two independent processes that operate additively with separate main effects (Demerouti et al., 2001; Gonzalez-Mulé et al., 2021): a health impairment process activated by increased demands that pressure individuals to exert extra effort, potentially eroding health indicators through sustained distress (Li et al., 2013), and a motivational process triggered when individuals perceive greater resource availability, leading to enhanced job engagement (Demerouti et al., 2019; Hakanen & Roodt, 2010).

This study operationalizes these dual processes through fatigue and dedication for both theoretical and practical reasons. Fatigue, defined as *"the inability to function at the desired level due to incomplete recovery from the demands of prior work and other waking activities"* (Kandera et al., 2019, p. 279), represents the quintessential health impairment outcome in aviation contexts. The determinants and consequences of fatigue are widely recognized as critical issues by both aviation scholars (Bendak & Rashid, 2020; Lee & Kim, 2018; Lin et al., 2024) and professional entities (IATA, 2025b), with established empirical links between crew scheduling practices and fatigue levels (Lee & Kim, 2018).

Fatigue is widely recognized as a critical issue in the aviation industry (IATA, 2025b), with particular significance for modern flight operations (Caldwell, 2005). Its impact on safety has been well-documented (Bendak & Rashid, 2020; Caldwell, 2005; Kandera et al., 2019; Lee & Kim, 2018; Lin et al., 2024) and research has established a clear link between fatigue and crew scheduling practices (Lee & Kim, 2018).

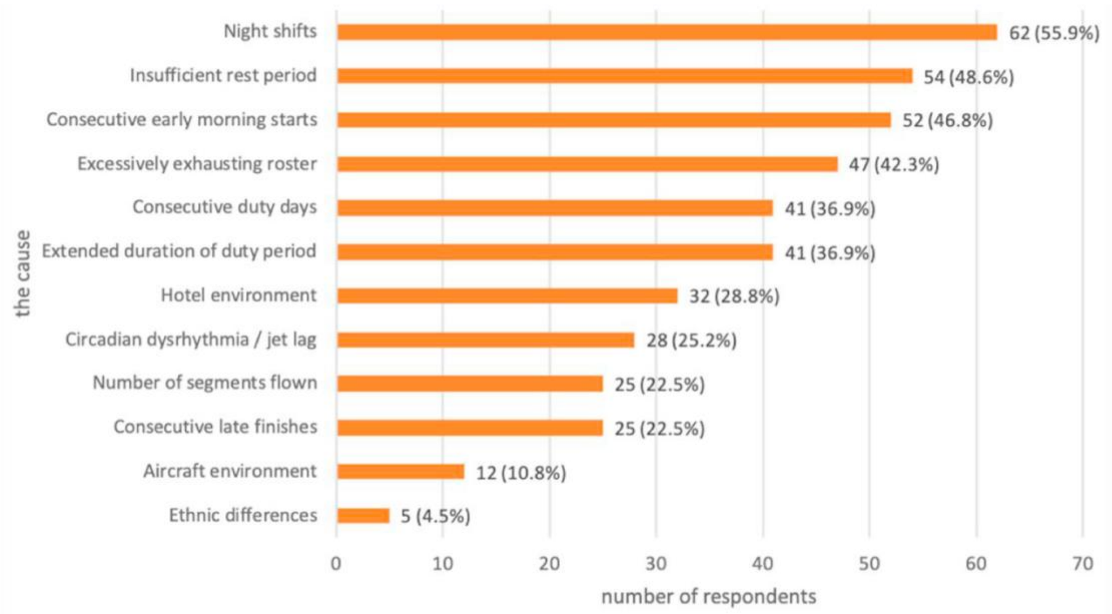

Figure 12: Most common causes of fatigue experienced by flight crew members
Source: (Badánik et al., 2021, p. 228)

The relationship between fatigue and crew scheduling is particularly noteworthy. Factors such as long duty hours, irregular work patterns, and frequent time zone changes inherent in many flight schedules, can contribute significantly to crew's fatigue

(Bendak & Rashid, 2020). As a result, there seems to be a growing emphasis on developing more effective scheduling practices to mitigate the effects of fatigue on aviation safety (Lin et al., 2024; Rodrigues et al., 2023). This makes fatigue particularly relevant for examining how rostering passageways affect crew health outcomes.

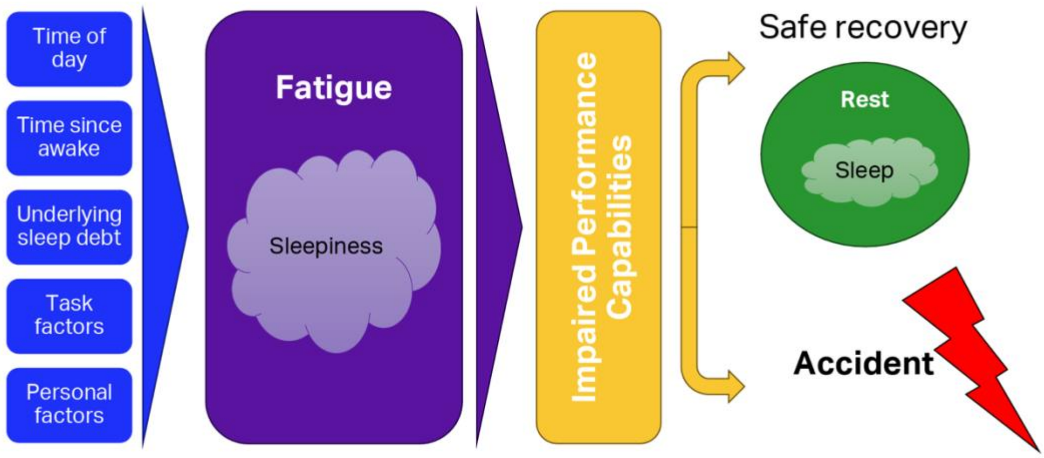

Figure 13: Key Components of Proactive Fatigue Hazard Identification
Source: (IATA, 2025a)

For the motivational process, this work focuses specifically on dedication because it represents the emotional core of engagement, manifesting as strong work involvement accompanied by feelings of meaning, enthusiasm, inspiration, and pride (Sinval et al., 2018). Theoretically, dedication stands out as the foundational element that serves as a prerequisite for the other engagement components of vigor and absorption (Kuntsi, 2014). This positioning makes dedication the most appropriate indicator of the motivational process triggered by enhanced resource availability through facilitative rostering passageways.

Work engagement represents a positive and fulfilling mental state related to one's job characterized by three key components: vigor, dedication and absorption (Kuntsi, 2014). These work engagement components are distinct in their nature: vigor entails a behavioural-energetic aspect, absorption a cognitive dimension, and dedication an emotional element (W. B. Schaufeli & Bakker, 2010). Kuntsi (2014), considers dedication to be essential, as it serves as prerequisite for both vigor and absorption. This perspective aligns with this work's view of dedication, fundamentally how job resources and this sense of meaning form a foundation for positive employee outcomes.

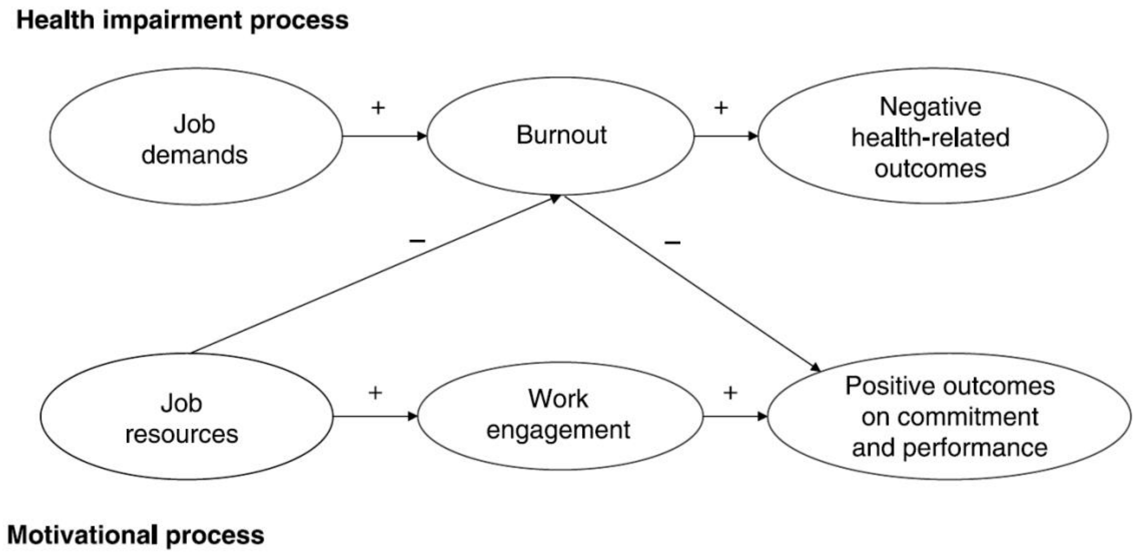

Figure 14: The complete dual process of the job demands-resources model
Source: Schaufeli & Bakker (2010)

By integrating these frameworks, this work proposes that advanced preferential bidding policies create facilitative caravan passageways through specific COR and JD-R mechanisms. From a COR perspective, the autonomy and inclusion provided by advanced policies function as critical job resources that crew members can both access and preserve. Autonomy over scheduling represents a fundamental resource because it enables crew members to align work demands with their personal resource pools, preventing resource depletion through better temporal control and predictability. Inclusion in decision-making constitutes an additional resource that enhances crew members' sense of agency and organizational support, creating protective conditions against resource loss threats (Hobfoll et al., 2018). These facilitative passageways establish ecological conditions that not only provide direct resource access but also reduce vulnerability to resource loss, potentially initiating the resource gain spirals that COR theory predicts occur when individuals operate from resource-rich environments (C.-F. Chen & Chen, 2014).

From a JD-R perspective, the enhanced resource availability created by these facilitative passageways triggers two independent processes in theoretically predictable ways. The superior resource allocation management enabled by greater autonomy and inclusion should activate the motivational process by providing crew members with sufficient job resources to meet work demands effectively, leading to increased dedication as work becomes more meaningful and personally fulfilling (Hakanen & Roodt, 2010).

Simultaneously, these resources should disrupt the health impairment process by reducing resource depletion patterns that force crew members to exert extra effort to cope with demanding scheduling constraints, thereby lowering fatigue levels (Li et al., 2013; Lin et al., 2024). This aligns with research demonstrating that crew participation in work allocation allows employees to align job demands with individual preferences and requirements, effectively mitigating fatigue (Liu et al., 2023; Wang et al., 2023).

Conversely, rostering and simple preferential bidding policies create restrictive caravan passageways that establish resource-poor ecological conditions. These policies limit crew access to scheduling autonomy and decision-making inclusion, creating environments where resource conservation becomes the primary focus rather than resource growth. Under these restrictive conditions, crew members must continuously invest effort to cope with imposed schedules that conflict with their resource management needs, activating the health impairment process and perpetuating fatigue while constraining access to meaningful work experiences that foster dedication development. This is consistent with fatigue risk management systems research emphasizing that poorly designed rosters contribute to fatigue accumulation and impaired cognitive functions (IATA, 2025b; Lin et al., 2024; Wen, 2024).

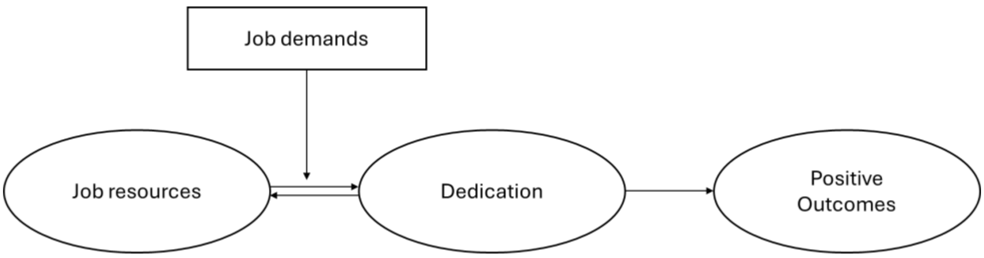

Figure 15: Modified JD-R model of work engagement
Source: Schaufeli & Bakker (2010)

This work's research builds upon the fundamental understanding that rosters significantly impact both the well-being and operational performance of flight crew (Wen, 2024). It is argued that individual crew members maintain intimate knowledge of their personal performance capacities, physical constraints, and life circumstances that directly influence their professional effectiveness (Mizzi et al., 2024). Thus, this study contends that through advanced preferential bidding crew members may be able to better manage their resource allocation, reducing the likelihood of resource depletion that contributes to negative health consequences (i.e., increased fatigue) (Lin et al., 2024). Similarly, when crew members possess greater control over their work schedules, they are more likely to experience their work as meaningful and personally fulfilling (i.e., increased dedication).

2.8. EFFECTS ON FLIGHT CREW SAFETY BEHAVIOURS

The psychological outcomes established in our previous hypotheses have important implications for critical organizational outcomes, particularly safety behaviours. Safety holds paramount importance within the aviation industry due to the high reliability conditions under which these organizations operate (ICAO, 2024; O'Neil & Krane, 2012).

While organizational research has traditionally viewed safety behaviours as employee compliance with behavioural safety routines, recent research in aviation industry advocates for a more comprehensive model that encompasses multiple safety initiatives (C.-F. Chen & Chen, 2014; Fugas et al., 2012).

These factors can contribute positively by not only enhancing safety procedures but also helping organizations to gain insight into their influence on safety behaviours. Prior research has demonstrated that organizational factors affect safety behaviours (Hadikusumo et al., 2017; Killimett, 2006; Mullen, 2004), with addition of a more specific approach by (C.-F. Chen & Chen, 2014) regarding JD-R effects on cabin crew safety behaviours. Thus, this work propose expanding their contribution to flight crew in general (i.e., pilots and cabin crew) from different cultures and organizations.

In this context, it is argued that crew participation on work allocation, through preferential bidding, may offer a pathway to mitigate fatigue and enhance safety behaviours by effectively aligning flights crews specific job demands with their individual preferences and personal requirements (Liu et al., 2023).

This work additionally adds valuable insight to academic literature regarding the impact of preference stating rostering systems and their impact on safety (Lee & Kim, 2018), addressing a gap in linking rostering systems to safety behaviours in the aviation industry.

This study contends that examining whether and how organizational factors (like different bidding policies) influence flight crew safety behaviours becomes essential (Liu et al., 2023; Mullen, 2004). Exploring the connection between bidding policies and safety behaviours assumes particular relevance due to the critical role crew schedule play in influencing fatigue levels, well-being and operational performance (Liu et al., 2023; Wang et al., 2023). Literature on fatigue risk management systems (FRMS) emphasizes that poorly designed rosters contribute significantly to fatigue accumulation, which may impair cognitive functions and compromise safety behaviours among flight crew (IATA, 2025b; Lin et al., 2024; Wen, 2024).

According to Fugas et al. (2012, p. 469), *"organizations typically view safety behaviours as employee compliance with behavioural safety routines"*. In the particular context of aviation, these behaviours comprise undertaking safety procedures established by the airline and reglementary authorities (C.-F. Chen & Chen, 2014). Though, this one-dimensional model of safety performance has been challenged, with research arguing that a more expanded model, that would include other safety initiatives, would be more comprehensive (Fugas et al., 2012).

Following this reasoning, Chen and Chen (2014) recognizes three distinct types of safety behaviours: in-role safety behaviours (ISB), defined as employee compliance with established safety procedures and standard operational protocols; extra-role safety behaviours (ESB), encompassing discretionary safety actions that extend beyond standard requirements, such as assisting coworkers and promoting safety initiatives; and upward safety communication (USC), representing flight crews' willingness to voice safety concerns, share observations, and propose evidence-based recommendations to enhance organizational safety performance.

In-role safety behaviours are defined as the employee's compliance with safety procedures (C.-F. Chen & Chen, 2014). In the particular case of flight crew, this would be defined as the degree of adherence to standard operational procedures established in order to safely conduct a flight. In addition, everything which extends beyond standard role safety compliance, such as assisting coworkers and promoting safety initiatives, are viewed as extra-role safety behaviours (C.-F. Chen & Chen, 2014; Fugas et al., 2012).

ESB is characterized by its discretionary and voluntary nature, reflecting employee's motivation to foster a safe work environment (Fugas et al., 2012). These behaviors include actions and practices that deliberately extend beyond prescribed role requirements and mandatory safety protocols (Fugas et al., 2012), demonstrating employees' proactive engagement in organizational safety culture.

Finally, Chen and Chen (2014), emphasizes still, the critical role of communication, particularly the importance of subordinates to take initiative to communicate or suggest safety-related matters to their supervisors. Given their specific job context, flight crew are in a unique position to observe and evaluate the practical effectiveness of the airline's safety policies in real-world scenarios (C.-F. Chen & Chen, 2014; S.-C. Chen, 2017). USC refers to the willingness of flight crew to voice safety concerns, share observations, and propose evidence-based recommendations designed to enhance overall safety performance within their organization (C.-F. Chen & Chen, 2014).

According to COR (Hobfoll, 2011), bidding policies that endow aircrews with greater resources (autonomy and inclusion) should positively affect individuals' behaviours. Drawing on the JD-R (Bakker & Demerouti, 2007) premises, this should happen through a health process and a motivational process. That is, individuals with great job resources should experience favourable health (reduced fatigue) and greater motivation (increased dedication). Consequently, this should bring positive consequences for behaviour. In our model, this should translate into greater engagement in both in-role and extra-role safety behaviours.

Reduced fatigue is particularly relevant for safety behaviours because fatigue systematically impairs the cognitive resources necessary for complex procedure execution, depletes the psychological energy required for discretionary helping behaviours, and reduces the mental capacity needed for proactive problem identification and communication (Bendak & Rashid, 2020; Lin et al., 2024). Conversely, enhanced dedication drives safety performance through increased personal investment in role requirements, heightened intrinsic motivation for voluntary contributions, and stronger commitment to organizational safety outcomes (C.-F. Chen & Chen, 2014; Khushnood et al., 2020b).

Given autonomy's nature as an intrinsic dimension directly tied to job content and individual control over immediate work processes, it should influence safety behaviours through pathways that reflect its job design characteristics (Dettmers & Bredehöft, 2020). Autonomy over scheduling enables crew members to exercise meaningful control over their work schedules and timing, allowing them to strategically align work demands with their personal circadian rhythms and recovery needs (Knudsen et al., 2007). For instance, when pilots bid for routes matching their natural sleep patterns or cabin crew successfully avoid consecutive night shifts, this control directly prevents resource depletion by enabling optimal work-rest cycles (Liu et al., 2023; Wang et al., 2023). The resulting resource preservation subsequently enables thorough safety procedure execution, maintains energy reserves for discretionary helping behaviours like mentoring junior colleagues, and sustains the mental clarity needed for proactive safety communication (IATA, 2025b; Lin et al., 2024; Wen, 2024).

Simultaneously, autonomy increases dedication capacity by enhancing employees' intrinsic motivation through personal control over core job design elements (W. Schaufeli & Salanova, 2007). This individual control creates a sense of personal agency and ownership over work scheduling that fundamentally makes the job more meaningful and fulfilling (Hackman & Oldham, 1976). When crew members experience this intrinsic control over their immediate work environment, it translates into increased dedication that motivates conscientious execution of safety protocols, fosters personal drive for voluntary safety initiatives, and enhances individual commitment to maintaining exemplary safety standards (Zhang et al., 2017) .

Inclusion in decision-making operates as an extrinsic dimension that extends beyond task-specific parameters to encompass broader organizational processes, requiring different theoretical mechanisms (Stiglbauer & Kovacs, 2018). It involves genuine consultation and consideration in managerial decisions affecting multiple employees (Nishii, 2013) such as providing input on duty time regulations, route planning policies, or crew base assignments. This participative involvement in broader organizational decisions systematically reduces the psychological stress (Merlini et al., 2019) and sense of powerlessness associated with imposed organizational conditions, effectively combating the fatigue that emerges from feeling disconnected from decision-making processes that shape work life (IATA, 2025b; Wen, 2024). The resulting fatigue reduction enables thorough procedure execution, preserves psychological resources necessary for colleague assistance, and reduces communication barriers that might otherwise inhibit safety reporting.

Moreover, when crew members are authentically consulted and considered in these broader decisions, it strengths its relationship with the organization and enacts a sense of belonging that transcends individual job tasks, creating dedication rooted in organizational identification rather than solely job content satisfaction (Le et al., 2021) . This organizationally oriented dedication subsequently motivates meticulous safety compliance as a meaningful contribution to organizational goals, drives voluntary safety contributions that benefit the broader organizational community, and encourages proactive sharing of safety insights that can improve organizational-level safety outcomes (Van Scotter & Motowidlo, 1996).

It is presumed that job demands and resources may affect employees' job outcomes, in this particular case safety behaviours. Thus, it is assumed that flights crew's perceptions of greater job resources will endow a positive effect on their safety behaviours while increased job demands will have an opposite effect. In consequence, this study proposes that individuals with higher levels of fatigue have a negative effect on in-role and extra-role safety behaviours while those with high levels of dedication will have a positive effect.

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3. METHODOLOGY

3.1. Studies overview

This research framework rests on three key propositions. First, research follows the central assumption of resource-based theories that individual performance depends on resource availability, with organizations responsible for creating conditions that either facilitate or hinder employees' access to necessary performance resources. This work draws on COR theory's caravan passageways principle to argue that crew rostering policies create distinct organizational conditions that affect employees' resource access (Hobfoll et al., 2018). Three primary rostering policies – i.e., traditional rostering, simple preferential bidding, and advanced preferential bidding - differ in the extent to which they allow employee input into schedule preferences through their bidding mechanisms. These differences create varying organizational caravan passageways that either facilitate or constrain crew members' ability to acquire, preserve, and invest personal and professional resources, primarily through the levels of autonomy and decision-making inclusion they provide.

Second, this work proposes that rostering policies perceived as promoting autonomy and inclusion in decision-making enable employees to acquire additional resources while resisting resource depletion (Hobfoll et al., 2018). Integrating the JD-R model, this research specifies that employees should experience increased motivation and reduced job demands (Bakker et al., 2023), which this work operationalizes as enhanced dedication and reduced fatigue, respectively.

Finally, this work posits that these resource-related processes ultimately influence flight crew safety behaviours. Specifically, when employees perceive greater autonomy and inclusion in decision-making from their rostering policies, they are more likely to engage in safety behaviours (that is, in-role performance, extra-role behaviours, and upward safety communication) due to the enhanced dedication and reduced fatigue they experience.

This work entails two quantitative studies to test the presented research model. Study 1 employed a quasi-experimental research design using experimental vignette methodology (Aguinis & Bradley, 2014) to examine whether different crew rostering policies (traditional rostering, simple preferential bidding and advanced preferential bidding) were associated with distinct levels of autonomy and inclusion (H1) and whether they impact individuals' levels of dedication and fatigue (H2). This design is particularly suitable for establishing causal relationships while minimizing concerns about internal validity (Podsakoff & Podsakoff, 2019).

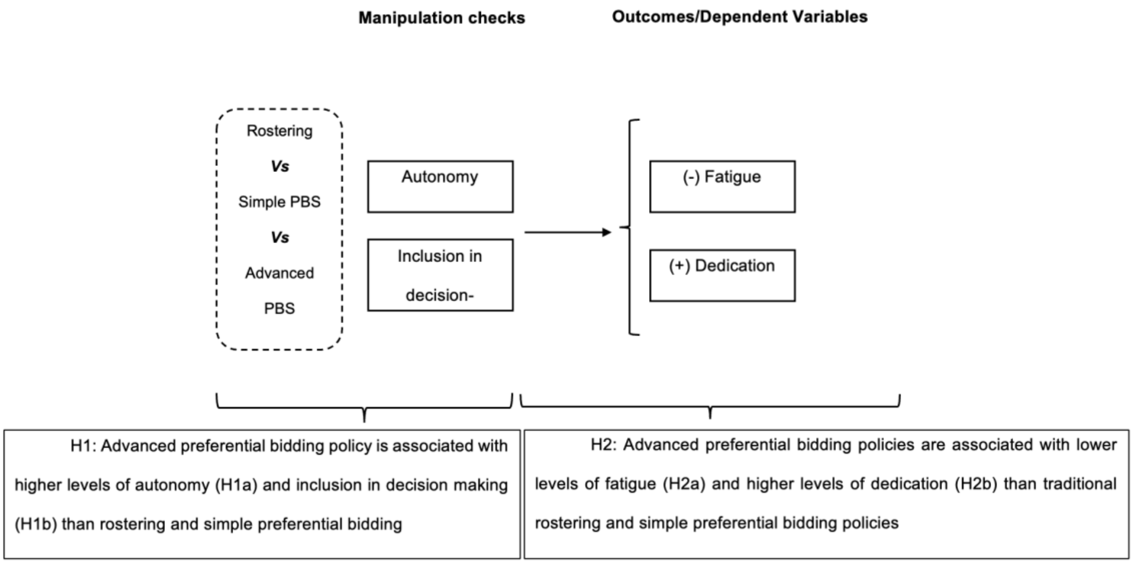

Figure 16: Study 1 research model
Source: Own Elaboration

The purpose of Study 2 was to extend the findings of Study 1 by assessing the effect of autonomy and inclusion on safety behaviours through enacted dedication and reduced fatigue. Acknowledging the limitations of experimental studies in establishing external validity (Aguinis & Bradley, 2014), time-lagged panel design was conducted with a sample of flight crew members (pilots and cabin crew), using two data collection points with a one-month interval between surveys. This time lag was selected based on scholars' recommendations to use "shortitudinal" research designs (Dormann & Griffin, 2015) to detect maximum effect sizes across measurement waves. Moreover, this work did not restrict the study to one airline but collected data from employees across airlines worldwide, thereby improving the generalizability of our findings (Van Quaquebeke et al., 2022).

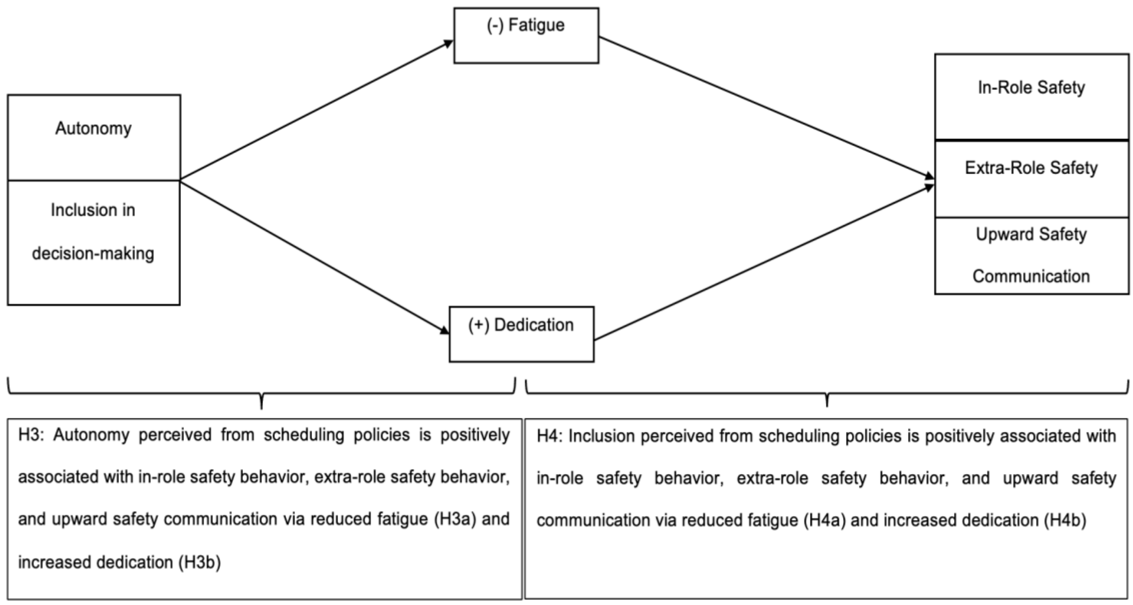

Figure 17: Study 2 research model
Source: Own Elaboration

3.2. Study 1

Sample and procedures

Participants were recruited through Prolific platform (http://prolific.ac; Peer et al., 2017), between May and June 2024. This work restricted search for participants to those who have indicated that were pilots and cabin crew, to assure familiarity with the scenario (Podsakoff & Podsakoff, 2019). As a second verification check, a question in the survey was included asking if the participant was working as a cockpit or cabin crew at the time of the study. Participants received a compensation of approximately .82€ for their participation.

This work only considered participants that met the screening criteria (i.e., being pilot or a cabin crew), provided voluntary consent to participate in the study, and correctly answered all attention check questions. None of the participants failed the attention checks and all of them confirmed that were working as flight crew at the time of the study. A total of 160 answers were collect. Six participants did not disclose any demographics. Only one participant opted for not revealing their gender, 91 identified as male (56.9%). The age average was 33.78 years (*SD* = 9.42; min = 20; max = 66) and 71.3% were cabin crew. Regarding the type of operation (i.e., Short/Medium-Haul, Long

Haul or Both), 54.4% were flying on short/medium-haul operation, while 10% were flying on both.

Three hypothetical scenarios were developed each describing the characteristics of each crew rostering policy targeted in our study: traditional rostering, simple preferential bidding policies and advanced preferential bidding. The scenarios were developed based on the descriptions of each crew rostering process available on the literature (Achour et al., 2007; Barnhart, 2009; Efthymiou et al., 2021; Gamache et al., 1998; Isabelle Kinnunen, 2015; Kohl & Karisch, 2004; Le Duc & Badánik, 2021; Maenhout & Vanhoucke, 2011; Meskanen, 2024; Wen, 2024) as well as on the technical description of the functioning of each system (Jeppesen, 2024; Navblue, 2024). The scenarios varied in the degree to which flight crew members could make requests (i.e., bidding) and influence their personal monthly roster. Participants were instructed to imagine the described scenario as vividly as possible. To enhance perception and realism, images and the layout of airline's scheduling software currently available on the market were incorporated. Participants were randomly assigned to only one of each scenario depicting a particular crew rostering system, therefore minimizing primacy and tiredness effects of being exposed to multiple experimental conditions (Auspurg & Jäckle, 2017), which could confound the results. They were asked to imagine themselves working as flight crew (either (co)-pilot or cabin crew) for an airline called Global X. All participants received the same information describing the organization: "*Global X is an airline operating an extensive domestic and international route network across the world. Their fleet consists of both narrowbody and widebody aircrafts. With 30 years of existence, they've shown strong resilience on a competitive market with stable grow throughout the years*". In the traditional rostering condition, participants could request any specific activities (either flights or days off), and the only mechanism for obtaining a particular day off or flight assignment is through swapping with colleagues. Under this system, the airline's scheduling department maintains complete control over flight crew rosters.

In the *simple preferential bidding* condition participants could request up to four pairings, ranked in order of priority, with the restriction that only one request would be fulfilled in the following monthly roster. Additionally, crew members may also request a day off. The fulfilment of both pairings and day-off requests depends also on the employee's seniority within the airline, creating a hierarchical allocation system. This means that, if both employees request the same activity, priority would be given to the most senior one. Finally, on advanced preferential bidding condition participants were allowed to specify a variety of preferences – such as avoiding certain destinations or prioritizing specific layover pairings – and were told that this crew rostering would try to accommodate these preferences to the maximum extent possible. As with *simple preferential bidding condition*, the assignment of these requests remains contingent upon the individual's seniority within the airline.

After reading the conditions, participants were asked to rate the level of autonomy and inclusion felt from using that crew scheduling policy of Global X. Afterwards, participants were asked to imagine working for that airline and rate their levels of dedication and fatigue.

Table 2: Study 1 demographics
Source: Own Elaboration

	N	%
Gender		
Male	91	56.9
Female	60	37.5
Prefer not to say	9	5.6
Age		
Prefer not to say	8	5.0
<25 years	32	20.0
25-29	26	16.3
30-34	36	22.5
35-39	23	14.4
>39 years	35	21.9
Occupation		
Prefer not to say	8	5.0
Pilot	38	23.8
Cabin Crew	114	71.2
Operation		
Prefer not to say	8	5.0
Short/Medium-Haul	87	54.4
Long Haul	16	10.0
Both	49	30.6

N = 160

Instruments

This work used well-established measure to collect data. Whenever possible, short versions of each scale were used to enhance the efficiency of our surveys and mitigate potential biases due to fatigue or lack of attentiveness (Hamaker, 2023).

Autonomy. To measure this variable, the three original items were adapted from the scale advanced by (Breaugh, 1999) . The items were slightly modified to align with the context of flight crew's work particularities. Also, an additional item was added added to address the flight crew's ability to choose activity locations (where). Participants rated each item using a scale ranging from 1 = strongly disagree to 7 = strongly agree. Sample items are: "I have control over the scheduling of my work" and "This rostering system allows me to decide where to perform specific work activities". The Cronbach's alpha was .93.

Inclusion in decision making. This variable was measured using the items developed by (Nishii, 2013). Six out of the eleven original items where retained. Wording of the items was adjusted to reflect inclusion regarding the scheduling system. Participants rated each item using a scale ranging from 1 = strongly disagree to 7 = strongly agree. Sample items are: "This is a scheduling system in which employees make use of their knowledge to enhance their work" and "In this scheduling system, employee input is actively sought". The Cronbach's alpha was.94.

Fatigue. Fatigue was measured using the Copenhagen Burnout Inventory (CBI) (Kristensen et al., 2005). All original items were retained, with modifications made only to temporal verbs to ensure appropriate contextual interpretation. For instance, the original item was adapted from "How often do you feel tired?" to "I would often feel tired" to better align with the scenario's temporal framework. Participants rated each item using a scale ranging from 1 = strongly disagree to 7 = strongly agree. The Cronbach's alpha was .96.

Dedication. To measure this variable, the three items of Utrecht Work Engagement Scale were used (W. Schaufeli & Bakker, 2003). Only the temporal verbs were modified to ensure appropriate contextual interpretation. For example, one of the original items was adapted from "My job inspires me" to "I would feel inspired in this job". Participants rated each item using a scale ranging from 1 = strongly disagree to 7 = strongly agree. The Cronbach's alpha value for this scale is .89.

3.3. Study 2

Study 2 was a time-lag panel design, with two data collection moments, one-month apart. We collected data for Study 2 through several sources. First, this work leaned on the contacts from the first author of this study who is a pilot of a European commercial airline. Also, our study was disclosed through diverse professional and social channels, including LinkedIn, WhatsApp groups, Facebook and international flight crew unions, thereby ensuring global reach and a wide spectrum of participants.

In Time 1 (T1), data was collected from July 2024 to October 2024, using an online survey created on Qualtrics platform. During this period, a total of 585 participants opened the link and started filling the survey. We deleted 177 surveys due to incompletion or failure to our attention checks, which result in a sample of 408 participants in T1. Participants were asked to provide an email to receive the second survey one month after. Participants were assured that we only asked for their emails to pair their answers from both surveys. Confidentiality was assured and guaranteed, and emails would be deleted after pairing the responses. As for the demographics, 205 participants identified as female (50.2%) with an age average of 37.42 years (*SD* = 9.23; min = 20; max = 68). Regarding jobs and ranks, 167 were cockpit crew (of which 60.5% were first officers), and 241 cabin crews (of which 42.4% were not pursers or cabin supervisors). Regarding the type of operation (i.e., Short/Medium-Haul, Long Haul or Both), 35% were flying on short/medium-haul operation, while 26.7% were flying on both.

On Time 2 (T2), which occurred one-month after T1 – i.e., between August 2024 and September 2024 –the second survey was sent to T1 sample by the email provided by them in the first survey. After two friendly reminders, this work was able to pair 230 responses. 9 surveys were deleted due to failure in attention checks; thus, this research's final sample was composed of 221 participants who answered to both surveys. Only one participant opted for not revealing their gender, and 118 were from male participants (53.4%). The age average was 37.78 years (*SD* = 8.92; min = 22; max = 62) and 53.4% were cabin crew. Regarding the type of operation (i.e., Short/Medium-

Haul, Long Haul or Both), 32.6% were flying on short/medium-haul operation, while 37.6% were flying on both.

Table 3: Study 2 demographics
Source: Own Elaboration

	N	%
Gender		
Male	118	53.4
Female	102	46.2
Prefer not to say	1	0.4
Age		
<25 years	12	5.4
25-29	29	13.1
30-34	56	25.3
35-39	37	16.7
>39 years	87	39.4
Occupation		
Cabin Crew	118	53.4
Pilot	103	46.6
Operation		
Both	83	32.6
Short/Medium-Haul	72	29.9
Long Haul	66	37.6

N = 221

Instruments

This work measured autonomy, inclusion in decision making, fatigue and dedication using the same items used in Study 1. To measure safety behaviours, measures from (C.-F. Chen & Chen, 2014) were used. Participants were instructed to focus on their safety behaviours over the last month (i.e., since Time 1), and rated all items on a seven-point Linkert (1 = strongly disagree to 7 = strongly agree)

In-role Safety Behaviour (ISB). All original items were retained, with modifications made only to temporal verbs to ensure appropriate contextual interpretation. For instance, the original item was adapted from "During ground check, I will make sure all emergency equipment has been well-loaded" to "During ground check, I made sure all emergency equipment has been well-loaded". The Cronbach's alpha was .76.

Extra-role Safety Behaviour (ESB). Two original items were retained, with minor modifications made only to include both pilots and cabin crew. Sample items are: "I promote safety program within the organization" and "I put in extra effort to improve the safety on board". The Cronbach's alpha was .67.

Upward Safety Communication (USC). All original items were retained. Sample items are: "I feel comfortable discussing safety behaviours with my supervisor" and "I feel that my supervisor openly accepts ideas for improving safety". The Cronbach's alpha was .87.

Control Variables

Following the recommendations from Berneth and Aguinis (2016) variables that were selected were those that theoretically showed correlations with our outcome measures to prevent erroneous inferences. Accordingly, this research controlled work experience because flight crew members with greater experience may have encountered a broader range of operational scenarios and worked under varying bidding policies, potentially shaping their perceptions and responses to our performance measures. Moreover prior meta-analytic work revealed an established relationship with various work outcomes (Quińones et al., 1995; Van Iddekinge et al., 2019).

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4. Presentation of Results and Discussion

Study 1: Results

Bivariate correlations, descriptive statistics and reliabilities are reported in Table 4.

Manipulation Checks and Hypothesis 1

Participants rated autonomy significantly higher in *advanced preferential bidding* condition (*M* = 5.09, *SD* = 1.15) than in the *simple preferential* condition (*M* = 4.11, *SD* =1.27) and *traditional rostering* condition (*M* = 2.16, *SD* = 1.27). The results from the ANOVA revealed that these differences were statistically significant: *F* (2,157) = 76.81, *p* < .00. Similarly**,** participants rated inclusion significantly higher in *advanced preferential bidding* condition (*M* = 4.99, *SD* = 1.12) than in the *simple preferential bidding* condition (*M* = 4.38, *SD* = 1.19) and *traditional rostering* condition (*M* = 2.46, *SD* = 1.26). The ANOVA test demonstrated that these differences were statistically significant: *F* (2,157) = 64.35, *p* < .00. Taken together, these results support the effectiveness of this studies manipulation and provide support to hypothesis 1 which was theorized that advanced preferential bidding policies should be associated with higher levels of autonomy (H1a) and inclusion in decision making (H1b) than traditional rostering and simple preferential bidding policies.

Effects on fatigue and dedication

In hypothesis 2, it was argued *advanced preferential bidding policies* are associated with lower levels of fatigue (H2a) and higher levels of dedication (H2b) than *traditional rostering* and *simple preferential bidding policies*. An ANOVA was conducted that revealed that participants in *advanced preferential bidding* condition reported significantly lower levels of fatigue (*M* = 3.43, *SD* = 1.29) and higher levels of dedication (*M* = 5.11, *SD* = .99) than those on *traditional rostering* condition (*M* = 5.04, *SD* = 1.52; *M* = 3.45, *SD* = 1.31; for fatigue and dedication, respectively) and *simple preferential bidding* condition (*M* = 3.64, *SD* = 1.25; *M* = 4.80, *SD* = 1.24; for fatigue and dedication, respectively). These differences were statistically significant: *F* (2,157) = 21.75, *p* < .00; *F* (2,157) = 33.08, *p* < .00; for fatigue and dedication, respectively. Taken together these results provide support for hypothesis 2

Table 4: Descriptive statistics, reliabilities, and zero-order correlations (Study 1, N = 160)
Source: Own Elaboration

	Mean	**SD**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Autonomy	3.84	1.72	(.93)								
Inclusion	3.99	1.59	0.85**	(.94)							
Fatigue	4.00	1.52	-0.62**	-0.70**	(.96)						
Dedication	4.46	1.40	0.70**	0.74**	-0.69**	(.89)					
Age	-	-	0.11	0.03	-0.09	-0.00	-				
Gender	-	-	-0.14	-0.08	0.15	-0.08	-0.16	-			
Work experience	-	-	0.00	-0.07	0.03	-0.06	0.74**	-0.09	-		
Occupation	-	-	-0.02	0.04	0.13	-0.03	-0.05	0.32**	-0.10	-	
Type of operation	-	-	0.06	0.04	0.02	0.08	0.17*	0.11	0.19*	0.23**	-

Note. Gender was coded as 1 = male; 2 = female; 3 = prefer not to say. Work experience was assessed in years. Occupation was coded as 1 = Pilot to 2 = Cabin Crew. Type of operation was coded as 1 = Short/Medium-Haul; 2 = Long Haul; 3 = Both. Cronbach's alpha reported on the diagonal.

*p < .05. **p < .01.

STUDY 2: RESULTS

Bivariate correlations, descriptives and reliabilities are available on Table 5.

Analytical Strategy

This study used bootstrapping analysis to test the established hypothesis (SPSS macro, PROCESS, Model 4; Hayes, 2012) , because it avoids statistical power problems resulting from asymmetric and other nonnormal sampling distributions due to the test of indirect effects (MacKinnon et al., 2004). Moreover, it is suitable for smaller samples, because it calculates the intended statistical test in multiple resamples of the database (Preacher et al., 2007).

Hypotheses Testing

In hypothesis H3a, it was proposed that autonomy felt from crew rostering policy enhances in-role safety behaviours, extra-role safety behaviours, and upward safety communication through reduced fatigue. The results from PROCESS Model 4 demonstrated that autonomy was negatively related to fatigue (B = -.20 (.06), t = -3.21 (p <.05), 95% CI [-.33, -.09]). In turn, fatigue was non-significantly associated with in-role safety behaviours (B = -.01 (.04), t = -.28 (p = .78), 95% CI [-.10, .08]) and extra-role safety behaviours (B = .03 (.06), t = 0.50 (p <.001), 95% CI [-.10, .17]), but had a significant negative relationship with upward safety communication (B = -.18 (.08), t = -2.20 (p = .03), 95% CI [-.34, -.02]). Finally, the results revealed only a significant indirect effect of autonomy on the indirect effects of autonomy on upward safety communication via reduced fatigue (B = .04 (.02); 95% CI [.003, .09]). The indirect effect on in-role safety behaviours (B = .003 (0.01); 95% CI [-.02, .02]) and extra-role safety behaviours (B = -.004 (.02); 95% CI [-.04, .03]) was non-significant. Thus, our hypothesis H3a was partially supported.

In hypothesis H3b, it was predicted that autonomy should enhance in-role safety behaviours, extra-role safety behaviours, and upward safety communication through increased dedication. Consistent with theoretical expectations, the results demonstrated that autonomy was positively related to dedication (B = .16 (.07), t = 2.27 (p <.05, 95% CI [.21, .31]). Furthermore, the results demonstrated that dedication was positively related with all three safety behaviour outcomes: in-role safety behaviours (B

= .09 (.04), *t* =2.19 (*p* <.05, 95% CI [.01, .16]), extra-role safety behaviours (*B* = .20 (.06), *t* = 3.26 (*p* <.001), 95% CI [.08, .32]) and with upward safety communication (*B* = .21 (.07), *t* = 2.87 (*p* <.05, 95% CI [.06, .35]). When examining the indirect effects of autonomy on safety outcomes through dedication, this study found only significant result for both extra-role safety behaviours (*B* = .03 (.02); 95% CI [.003, .08]) and upward safety communication (*B =* .03 (.02); 95% CI [.003, .08]). The indirect effect of autonomy on in-role safety behaviours via dedication did not reach statistical significance (*B* = .01 (.01), 95% CI [-.002, .04]). These findings provide partial support for hypothesis H3b.

Hypothesis H4a proposed that inclusion enhances in-role safety behaviours, extra-role safety behaviours, and upward safety communication through reduced fatigue. As expected, inclusion was negatively related to fatigue (*B* = -.16 (.07), *t* =-2.22 (*p* <.05, 95% CI [-.30, -.02]). The indirect effects of inclusion on in-role safety, extra-role safety behaviours and upward safety communication, through the fatigue were non-significant (*B* = .002 (0.01); 95% CI [-.02, .02]; *B* = -.003 (.01); 95% CI [-.03, 0.02]; *B* = .03 (.02); 95% CI [-.001, .07]; respectively). Therefore, H4a was not supported.

Finally, on hypothesis H4b, it was posited that inclusion enhances in-role safety behaviours, extra-role safety behaviours, and upward safety communication through increased dedication. Consistent with theoretical expectations, inclusion was positively related to dedication (*B* = .38 (.08), *t* = 4.68 (p<.001, 95% CI [.21, .53]). The indirect effect of inclusion via dedication on in-role safety behaviours was non-significant (*B* = .03 (.02); 95% CI [-.002, .08]). In turn, this research found a significant indirect effect with extra-role safety (*B* = .07 (.03); 95% CI [.03, .13]) and upward communication (*B* = .08 (.03); 95% CI [.02, .15]). These findings provide partial support for hypothesis H4b. Table 6 summarizes the results.

Table 5: Descriptive statistics, reliabilities, and zero-order correlations (Study 2, N = 221)
Source: Own Elaboration

	Mean	**SD**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Autonomy	2.77	1.43	(.86)											
Inclusion	3.23	1.29	0.58**	(.87)										
Fatigue	3.74	1.18	-0.35**	-0.32**	(.87)									
Dedication	5.06	1.40	0.37**	0.44**	-0.54**	(.90)								
ISB	6.56	0.65	-0.00	-0.10	-0.01	0.17*	(.76)							
ESB	5.53	1.03	0.14*	0.15*	-0.14*	0.28**	0.23**	(.67)						
USC	5.06	1.32	0.25**	0.33**	-0.34**	0.39**	0.11	0.37**	(.87)					
Age	-	-	-0.12	-0.18**	-0.16*	0.06	0.03	0.14*	0.12	-				
Gender	-	-	-0.19*	-0.06	0.47**	-0.19**	-0.07	-0.13*	-0.16*	-0.24**	-			
Children	-	-	0.16*	0.20**	0.06	0.04	0.21	0.02	0.03	-0.56**	0.17*	-		
Occupation	-	-	0.22**	0.09	-0.48**	0.25*	0.04	0.08	0.14*	0.23**	0.81**	-0.21**	0.12	-
Type of operation	-	-	-0.24	-0.03	0.20	0.04	-0.04	-0.06	0.13	-0.03	0.07	0.01	-0.00	-0.05

Note. Gender was coded as 1 = male; 2 = female; 3 = prefer not to say. Work experience was assessed in years. Occupation was coded as 1 = Pilot to 2 = Cabin Crew. Type of operation was coded as 1 = Short/Medium-Haul; 2 = Long Haul; 3 = Both. Cronbach's alpha reported on the diagonal. Abbreviations: ISB, In-Role Safety Behaviours; ESB, Extra-role Safety Behaviours; USC, Upward Safety Communication. *p < .05. **p < .01.

Table 6: Bootstrapping analysis results (Study 2, N = 221)
Source: Own Elaboration

	Mediators (T1)						Dependent Variables (T2)								
	Fatigue			Dedication			In-Role Safety			Extra-Role Safety			Upward communication		
Controls	*B*	*t*	*95% CI*	*B*	*t*	*95% CI*	*B*	*t*	*95% CI*	*B*	*t*	*95% CI*	*B*	*t*	*95% CI*
Work experience	-0.01	-1.35	[-0.03, 0.005]	0.01	0.59	[-0.01, 0.02]	0.002	0.42	[-0.01, 0.01]	0.02	2.66	[0.005, 0.03]	0.01	0.83	[-0.01, 0.02]
Independent Variables															
Autonomy	-0.21	-3.25	[-0.33, -0.08]	0.17	2.29	[0.02, 0,31]	-0.02	-0.56	[-0.10, 0.05]	0.06	1.09	[-0.05, 0.18]	0.09	1.22	[-0.05, 0.23]
Inclusion	-0.16	-2.35	[-0.31, -0.03]	0,38	4.71	[0.22, 0.54]	0.01	0.16	[-0.08, 0.09]	0.03	0.39	[-0.11, 0.16]	0.28	3.54	[0.13, 0.44]
Mediator															
Fatigue							-0.01	-0.24	[-0,10, 0.08]	0.03	0.50	[-0.10, 0.17]	-0.17	-2.12	[-0.34, -0.12]
Dedication							0.09	2.18	[0.01, 0.16]	0.20	3.30	[0.08, 0.32]	0.20	2.87	[0.06, 0.35]

Note: *N*=221; Unstandardized regression coefficients; CI = Confidence intervals; T1= Time 1; T2= Time 2 (one-month after T1)

Discussion

This research explored the effect of crew rostering policies on flight crew safety behaviours. A theoretical framework was developed by integrating COR theory (Hobfoll et al., 2018) and JD-R model (Bakker & Demerouti, 2007), and conceptualized crew bidding policies as caravan passageways that create different levels of autonomy and inclusion in decision-making, subsequently influencing crew fatigue and dedication levels, which then affect safety behaviours. This research focused on flight crew because they represent an unique occupational group with significantly different working conditions and access to resources compared to other occupations (Demerouti et al., 2019).

Study 1 results provided support for Hypotheses 1 and 2, demonstrating that crew rostering policies with more extensive bidding capabilities (i.e., advanced preferential bidding) are associated with higher levels of autonomy and inclusion, as well as lower fatigue and higher dedication levels. Study 2 results revealed more nuanced mediation patterns than hypothesized.

For Hypothesis 3, perceived autonomy from crew rostering policies was positively associated with upward safety communication via both reduced fatigue and increased dedication pathways. Additionally, perceived autonomy showed an indirect effect on extra-role safety behaviours through increased dedication only, with no significant fatigue-mediated pathway.

For Hypothesis 4, inclusion in decision-making perceived from crew rostering policies was positively associated with both upward safety communication and extra-role safety behaviours via increased dedication only. No indirect effects of inclusion on safety behaviours were found through the fatigue reduction pathway. Notably, neither autonomy nor inclusion in decision-making showed any effects on in-role safety behaviours through either mediation pathway, indicating that mandatory safety procedures remained unaffected by scheduling policy variations.

These empirical findings demonstrate strong theoretical alignment with previous research grounded in the JD-R and COR theoretical frameworks (C.-F. Chen & Chen, 2014; Li et al., 2013; Nahrgang et al., 2011). However, this research makes a significant theoretical contribution by specifically investigating how varying levels of resources, expressed through different bidding policies, impact flight crew safety behaviours.

This research particularly builds upon the foundational work of Chen and Chen (2014), who examined the relationship among job demands, job resources, and cabin crew safety behaviours. While Chen and Chen (2014) work demonstrated how job demands negatively correlates with safety behaviours and job resources possibility influence these outcomes, this study advances this theoretical understanding by conceptually positioning bidding policies as a specific job resource and empirically establishing their direct association with enhanced autonomy and inclusion.

Furthermore, these findings regarding the relationship between autonomy and inclusion with fatigue and dedication are well-supported by similar research (Hämmig & Vetsch, 2021; Jung et al., 2024; Khushnood et al., 2020a; Malinowska et al., 2018). This research presents a contrasting pattern to previous research, particularly when compared to the support found by Chen and Chen (2014) for the mediating role of job resources in the relationship between job demands and safety behaviours. While Chen and Chen's (2014) study demonstrated complete mediation of job resources across all three types of safety behaviours examined, our work achieved only partial mediation support along certain pathways within our theoretical model

Consistent with Khushnood et al. (2020a) and Portoghese et al. (2014), this research further emphasizes the critical importance of supportive organizational environment and resource availability. This theoretical framework suggests that when airlines provide crew members with greater control over their schedule, through wider bidding policies, they act as essential job resources that can buffer against the demanding nature of aviation work, potentially increasing dedication, reducing fatigue and enhancing safety behaviours.

THEORETICAL CONTRIBUTIONS

This research makes several significant theoretical contributions. First, this work offers a conceptualization of organizational policies as caravan passageways. By reconceptualizing crew bidding policies as institutional mechanisms that function as *"external factors that support, foster, enrich, and protect resources"* or conversely *"detract,* *undermine, obstruct, or impoverish people's resource reservoirs*" (Hobfoll, 2012, p. 229), this study provides a fresh theoretical lens for understanding how administrative systems determine employee resource access.

Second, this research developed and tested an integrated COR-JD-R theoretical framework that combines COR theory's ecological resource perspective with the JD-R model's dual process mechanisms. This integration demonstrates how ecological conditions (passageways) systematically trigger specific JD-R processes, creating a more comprehensive understanding of how organizational contexts influence employee outcomes while providing empirical evidence for resource gain spirals in organizational policy contexts.

Third, these findings reveal important theoretical distinctions between intrinsic and extrinsic organizational resources. Specifically, the differential mediation patterns for autonomy versus inclusion provide new insights into how different types of resources operate through distinct mechanisms. Autonomy, as an intrinsic job design resource, influenced safety behaviours (extra-role and upward safety communication) through both reduced fatigue and increased dedication pathways, while inclusion, as an extrinsic organizational resource, affected upward safety communication only through dedication enhancement. This suggests that intrinsic resources tied to individual job control may have broader effects on employee states, while extrinsic resources tied to organizational participation operate primarily through motivational mechanisms. The differential effectiveness of autonomy versus inclusion pathways may also reflect the individualistic nature of aviation work, where pilots and cabin crew operate in small, autonomous teams where individual control may be more psychologically salient than organizational participation (Demerouti et al., 2019). The non-significant indirect effect of inclusion through reduced fatigue reduction deserves deeper theoretical consideration and reveals important insights for future research. For example, inclusion may operate through different temporal mechanisms than autonomy. While autonomy provides immediate control over work scheduling that directly impacts fatigue patterns, inclusion involves participative processes that may influence fatigue through longer-term organizational trust and support mechanisms not captured in our time-lag (Dettmers & Bredehöft, 2020; Stiglbauer & Kovacs, 2018) . Moreover, inclusion's extrinsic nature may mean its anti-fatigue effects operate primarily through alternative pathways (e.g., organizational identification and commitment) rather than direct resource preservation (Mulyadi et al., 2025) . These insights suggest that future research should examine temporal dynamics of inclusion effects and explore whether alternative measurement approaches might reveal fatigue-related benefits operating through different timeframes. The consistent absence of effects on in-role safety behaviours across all mediation pathways suggests that mandatory safety procedures demonstrate remarkable resilience against resource-related variations, aligning with high-reliability organization theory (O'Neil & Krane, 2012) . For example, the lack of effects on in-role safety behaviours could reflect ceiling effects, where aviation's intensive training and regulatory requirements create such strong behavioural patterns that additional motivation has limited impact on already-optimized performance (Vaskova Kjulavkovska et al., 2022).

Fourth, this research reveals important insights for resource theories applications in safety-critical contexts. The finding that in-role safety behaviours remained unaffected by resource-related variations contributes to theoretical understanding of when and where resource theories apply versus where other mechanisms (regulatory frameworks, intensive training) may be more powerful. This extends resource theory by identifying contexts where behavioural adherence demonstrates resilience against resource fluctuations, contributing to high-reliability organization theory and safety science. Importantly, this finding both aligns with and extends existing aviation safety literature. While prior research has identified organizational factors as safety behaviour predictors (Mullen, 2004), this study is the first to establish specific pathways through which scheduling policies influence safety outcomes. The resilience of in-role safety behaviours aligns with research on aviation's robust safety culture (ICAO, 2024) but contrasts with findings in other industries where job resources more readily influence task performance (Bakker & Demerouti, 2024).

PRACTICAL CONTRIBUTIONS AND SPECIFIC INDUSTRY IMPLICATIONS

For airline managers, our findings provide specific guidance for scheduling system implementation. Prioritizing autonomy-enhancing features (individual schedule control) appears more effective for comprehensive crew outcomes than inclusion mechanisms alone. Airlines should focus on bidding systems that maximize individual control while supplementing with inclusion mechanisms to enhance dedication-related outcomes.

According to this research, implementation of advanced preferential bidding systems can lead to multiple benefits: lower fatigue and higher dedication among flight crew, which in turn supports an increase in voluntary safety behaviours.

While airlines would need to manage the complexities of implementing a preferential bidding system, the payoff in terms of a more engaged and well-rested flight crew could be substantial.

For regulatory bodies, our findings suggest that while core safety procedures remain robust across rostering variations, enhanced crew resource management through bidding policies can provide additional safety margins through improved voluntary safety behaviours and upward communication. This supports arguments for regulatory frameworks that encourage, though not mandate, crew preference systems within Fatigue Risk Management Systems (IATA, 2025b). Moreover, these work findings may provide regulators guidelines or incentives for airlines to adopt preferential bidding systems, as our research links such practises to lower fatigue levels and improved safety behaviours.

Scheduling software developers should prioritize autonomy-enabling features such as flexible bidding algorithms, real-time schedule modifications, and personalized preference matching. The demonstrated relationships between these systems and reduced fatigue, combined with enhanced dedication and voluntary safety behaviours, provide compelling value propositions for advanced scheduling technologies (Liu et al., 2023; Wang et al., 2023).

Lastly, these findings may also establish valuable grounds for flight crew unions to use in their negotiations with airlines and to provide valid and scientific-based arguments to argument for more advance PBS to be implemented.

Across management, regulator and employees, everyone benefits from crew friendly rostering systems. Employees would get work schedules tailored to their likings and/or needs, and airlines would get a more dedicated and less fatigued work force, while industry safety is maintained or improved.

5. CONCLUSIONS

This study begun primarily, though not exclusively, as a response to a gap in the academic literature. Airline scheduling has traditionally been approached as a technical and operational problem, with the primary goal of minimizing costs and maximizing workforce's efficiency. While this strategic perspective is both logical and necessary in such a competitive and highly regulated industry, it risks overlooking a crucial dimension: the workers who form the backbone of aviation operations.

The central aim of this thesis was therefore to redirect the conversation from a purely operational focus on efficiency and profitability to one that also recognizes the strategic importance of the workforce itself. By investigating how bidding policies affect flight crew, this research sought to emphasize that sustainable operations depend not only on technical optimization but also on the well-being, motivation, and engagement of employees.

The uniqueness of aviation professionals was a key driver of this investigation. Unlike many other professions, the working life of a flight crew member is affected by a set of highly distinctive characteristics. These professionals operate under irregular hours, often across multiple time zones, and are exposed to demanding working conditions that do not apply to conventional jobs. The standard 9-to-5 work model is irrelevant in this context, and other benefits common in other industries, such as remote work or flexible schedule, cannot be so easily implement for pilots and cabin crew.

Their work schedules are not only non-standard but also deeply braided with safety, regulatory compliance, and operational constraints. For this reason, it becomes important to explore mechanisms through which flight crew members can regain some level of control over their working lives. This study goal aims to address that need by focusing on preference-bidding systems (PBS), which provide opportunities for flight crew members to influence the shape of their monthly rosters.

Airlines around the world adopt different rostering systems according to their size, operational model, and strategic objectives. Some airlines use more restrictive systems, while others have invested in more advanced PBS that allow crew members to express preferences regarding days off, specific destinations, and many others. One of the most significant differences among these systems is the extent to which crew members are able to manipulate or influence their schedules. Like any employee, aviation professionals also have personal lives, family responsibilities, and individual physiological needs. The possibility of requesting time off for a family event, selecting a preferred flight destination, or avoiding a particular type of duty (such as night flights), could therefore in theory provide behavioural and performance-related benefits. However, while it may seem intuitive that this would be beneficial, such assumptions were only theoretical. Empirical evidence validating was needed, and this research pretends to fulfil that gap and open interest for further research.

As such, this study represents one of the first empirical examinations of how preference-stating opportunities in diverse crew scheduling policies influence flight crew safety behaviours, highlighting the importance of empowering flight crews to participate in shaping their monthly schedules for mutual employee and organizational benefits.

In doing so, this work also pursued to shift the framing of scheduling policies away from being a unilateral benefit for airlines to being a mutual benefit for both organizations and employees. The goal of this research is to provide compelling cases for the adoption of more advance PBS systems across the industry.

The findings of this work support this vision. First, this study confirmed that access to bidding mechanisms is strongly associated with higher levels of autonomy and inclusion in decision-making. Simply put, the broader the bidding systems, the more empowered flight crew members feel. Advanced PBS systems provide crew members with meaningful tools to influence their monthly rosters, thereby increasing their sense of autonomy and reinforcing their perception they are valued contributors to the scheduling process. This also aligns with organizational research linking autonomy to several individual's outcome performance variables. The empirical evidence provided here, not only validates existing theoretical expectations, but also extends them into the aviation domain.

Beyond autonomy and inclusion, this study also examined the relationship between bidding and two critical outcomes: fatigue and dedication. The operational realities of aviation (i.e., disrupted circadian rhythms, long duty hours, and frequent night flights) are well-documented as sources of fatigue for flight crew.

Numerous studies have already demonstrated the impact of scheduling on fatigue levels. The added value of this research was to examine whether giving crew greater influence over their schedules could mitigate fatigue and increase dedication. Since each crew members has unique needs and preferences, the ability to select rest days, duty patterns, or even destinations would allow individuals to manage their fatigue more effectively, and by having their requests fulfilled, increase their dedication.

The empirical findings support this rationale. Advanced PBS was associated with lower levels of fatigue and higher levels of dedication. Conversely, rostering, a restrictive system, had higher levels of fatigue and lower dedication. These findings are significant because they empirically confirm what has been proposed.

The final dimension of this investigation was to explore how studied rostering systems influence safety behaviours. Safety is the cornerstone of aviation, and flight crew compliance with standard operation procedures (SOP) in non-negotiable. The initial expectation was that rostering would not significantly affect in-role safety behaviours (such as SOP compliance) or extra-role safety behaviours, given that these behaviours are deeply inbreeded in the aviation industry. Findings partly confirmed this expectation.

Despite our analysis revealed only partial support for certain hypothesized mediation pathways related to safety behaviours, the findings demonstrate that standard operating procedures maintain their integrity regardless of scheduling variations, making a substantial contribution to understanding the robustness of established safety protocols in aviation.

Importantly, the partial support for some hypothesized mediations should not be interpreted as justification for rejecting preference-based scheduling systems, as our research clearly demonstrated that such systems yield significant benefits in terms of reduced fatigue and enhanced dedication among flight crew personnel.

These outcomes represent meaningful advantages that positively impact both individual well-being and organizational effectiveness, suggesting that airlines can implement advanced scheduling systems to enhance crew resource management while maintaining the integrity of critical safety procedures.

These implications extend beyond airlines. Aviation regulators, who play a central role in shaping industry practises, may also draw conclusions on these findings. The evidence presented suggests that regulators could encourage or provide guidelines for the adoption of more advanced rostering systems, particularly for airlines still using restrictive approaches. Such measures would not only support employee well-being but also strengthen industry's resilience, all while preserving aviation's safety standards.

5.1. LIMITATIONS

This study is not without limitations which lend themselves opportunities for future research. First, although the self-report measures for safety behaviours was appropriate for capturing safety behaviours that are inherently subjective and difficult to observe objectively, could be subject to bias (Kock et al., 2021; Podsakoff & Podsakoff, 2019) . The differential result patterns across safety behaviour types suggest that future research should maintain multidimensional safety assessments rather than using aggregate measures, yet future research could lean on other sources of data (e.g., direct supervisor ratings) (Spector, 2019).

Secondly, cultural considerations warrant attention. Aviation's global nature means crew cultural backgrounds may moderate responses to autonomy and inclusion, with collectivistic cultures potentially showing stronger responses to inclusion-based interventions, suggesting important avenues for cross-cultural theoretical development.

Finally, the assessment of the ESB measure revealed a Cronbach's alpha coefficient that fell below the commonly accepted threshold for reliable measurement (α = .67 vs α = .70; Bernstein & Nunnally, 1994; Christmann & Van Aelst, 2006). Consequently, we recognize that this lower-than-recommended reliability may impose limitations on the strength of the relationships observed in our findings.

5.2. FUTURE RESEARCH

Future research should explore additional mediating mechanisms beyond fatigue and dedication, potentially including work-life balance, schedule predictability, and social support resources (Badánik et al., 2021; Wen, 2024). By allowing people to better manage personal time and work, improved roster control, could enhanced work-life balance, which, in turn, could influence outcomes like job satisfaction.

Further research should also investigate whether implementing an advanced PBS could reduce absenteeism by mitigating crew fatigue and accommodating crew members' requests, thus decreasing the chance of absences that might otherwise result from denied requests.

Cross-cultural studies could examine whether our findings about intrinsic versus extrinsic resource effectiveness vary across cultural contexts. Research examining boundary conditions under which scheduling resources might influence mandatory safety procedures could provide valuable insights for extreme operational conditions where resource preservation becomes critical for procedural adherence.

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ANNEX 1 – STUDY'S DATABASE

STUDY 1: CLICK HERE

STUDY 2: CLICK HERE