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RESEARCH ARTICLE

The effect of crew rostering policies on flight crew safety behaviours

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Abstract

Crew rostering (i.e., designing and assigning work schedules for cockpit and cabin crew) is a core personnel management function in commercial airlines. Surprisingly, little is known about how rostering policies shape flight crews' psychological resources and safety performance. Combining Conservation of Resources theory and the Job Demands–Resources model, we investigate if rostering policies that provide greater opportunities to state schedule preferences foster perceived autonomy and inclusion in decision making, thereby reducing fatigue and strengthening dedication, with implications for safety behaviours. Study 1, a vignette experiment with flight crew members (N=160), shows that policies with more extensive preferential bidding options are perceived as providing greater autonomy and inclusion and, in turn, are associated with lower fatigue and greater dedication. Study 2, a one-month time-lagged panel study (N=221), extends these findings: perceived autonomy and inclusion predict extra-role safety behaviour and upward safety communication via increased dedication, with autonomy also reducing fatigue to enhance upward safety communication. Indirect effects on in-role safety behaviour were not significant. Overall, the findings suggest that rostering policies can shape flight crew safety performance, offering airlines actionable, evidence-based guidance for rostering-system design.

KEYWORDS

autonomy, crew rostering, dedication, fatigue, flight crew, inclusion, preferential bidding, safety behaviours

Aníbal López and João Bastos contributed equally and share first authorship.

Practitioner points

- Advanced crew scheduling systems that allow greater employee input significantly increase flight crew autonomy and dedication while reducing fatigue.
- Crew rostering policies with enhanced bidding capabilities improve voluntary safety behaviours and upward safety communication, but do not affect mandatory safety procedures.
- Autonomy in scheduling affects safety outcomes through both reduced fatigue and increased motivation, while organizational inclusion operates primarily through enhanced dedication.
- This study provides the first systematic empirical comparison of different airline crew rostering policies and their impact on flight crew safety performance.

INTRODUCTION

Commercial airlines operate as high-reliability organizations in which consistent performance is essential for service quality and financial stability (Chutima & Arayikanon, 2020). With personnel being the second-largest operating expense after fuel (International Air Transport Association [IATA], 2025), crew rostering sits at the core of airline operations by determining cockpit and cabin schedules amid legal and security requirements, collective agreements and crew preferences. This creates a complex optimization problem with clear implications for efficiency and service delivery (Azadeh et al., 2013; Novak et al., 2020; Quesnel et al., 2020). Accordingly, this "rostering problem" has drawn scholarly attention (Gopalakrishnan & Johnson, 2005), recently moving from a focus on cost and utilization optimization (e.g., Achour et al., 2007; Gamache et al., 1998; Kohl & Karisch, 2004) to a growing interest in how rostering policies shape the experiences and outcomes of the employees subject to these scheduling decisions (Badánik et al., 2021; Lee & Kim, 2018; Lin et al., 2024; Novak et al., 2020).

Despite these advances, research is still limited and has focused mainly on health and well-being outcomes such as fatigue and sleep (Badánik et al., 2021; Lin et al., 2024; Wang et al., 2023). In contrast, how crew rostering policies affect flight crew behaviour has received far less attention (Lin et al., 2024), leaving an incomplete understanding of a core personnel management practice in safety-critical work (Chutima & Arayikanon, 2020; Pasha & Stokes, 2018). Examining how rostering policies affect flight crew behaviour is important for both theoretical and practical reasons.

Crew rostering policies are a core, yet understudied, element of job design, determining when, how often and under what temporal configurations employees work, thereby shaping exposure to job demands and access to job resources in ways that task-focused models only partly capture (Dettmers & Bredehöft, 2020). Demerouti (2025) argues that job-design research must move beyond task content and consider how work arrangements structure the demand–resource balance, namely when and how work is scheduled and interspersed with recovery opportunities that underpin well-being and performance. From this perspective, crew rostering policies are not merely administrative constraints but meaningful job-design mechanisms that shape the temporal architecture of work and, in turn, behaviour and performance in demanding environments.

Managerially, airlines adopt different crew rostering-policy regimes—that is, the overarching scheduling systems or rule structures through which airlines allocate crew rosters and determine how much input employees have into work-allocation decisions—ranging from systems that invite substantial employee input to more centralized, management-driven approaches with minimal autonomy (Quesnel et al., 2020). Yet, to our knowledge, no empirical study has systematically examined the comparative behavioural implications of these policy regimes. This is especially consequential in aviation, where scheduling is central to fatigue risk management and, therefore, to safety outcomes (IATA, 2025; Lin et al., 2024; Wen, 2024). Studying rostering policies in this high-reliability context can thus inform

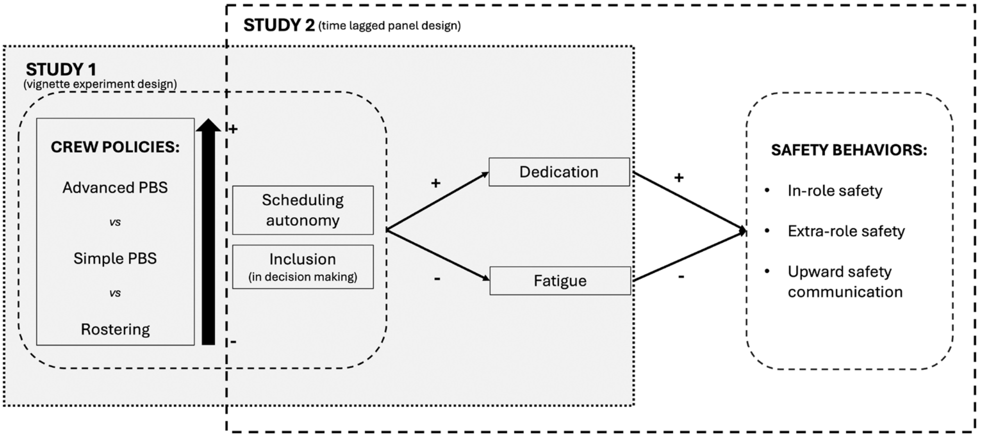

FIGURE 1 Research model. PBS, preferential bidding system.

how organizations design scheduling systems to support safe performance, not merely manage staffing (Demerouti, 2025).

Accordingly, this study examines how crew rostering policies affect flight crew behaviour by developing and testing a model that links rostering policies to flight crew safety behaviours. We focus on safety behaviours because they are central to flight crew work (Bendak & Rashid, 2020) and essential for the operational integrity of commercial aviation (Lin et al., 2024). Building on recent work in this area (e.g., Chen & Chen, 2014; Grant et al., 2024), we develop a resource-based framework that joins Conservation of Resources (COR) theory (Hobfoll, 2011) and the Job Demands–Resources (JD–R) model (Bakker et al., 2023; Demerouti et al., 2001). Firstly, we use COR theory as our overarching lens because it explains why performance depends on access to resources and how organizational conditions can facilitate or constrain that access. Drawing on COR's caravan passageways principle, we argue that crew rostering policies create organizational conditions that shape flight crew members' resource environments (Hobfoll et al., 2018). We examine three policy regimes—rostering,[1] simple preferential bidding and advanced preferential bidding—which differ in the degree to which they allow crew input into schedule preferences through bidding mechanisms. We propose that these regimes function as more or less facilitative passageways by varying the autonomy and decision-making inclusion they provide, thereby affecting crew members' capacity to acquire, protect and invest resources.

Secondly, to provide a more fine-grained perspective of how these resource conditions translate into specific psychological states and ultimately behaviour, we draw on the JD–R model. The JD–R specifies two core pathways through which job characteristics influence employees, namely a motivational process and a health-impairment process (Bakker et al., 2023; Demerouti et al., 2001). We operationalize these pathways as greater dedication and lower fatigue, respectively, and propose that these states, in turn, promote safety behaviour. Specifically, when crew perceive greater autonomy and inclusion in scheduling, they should display elevated in-role safety, more extra-role safety behaviour and stronger upward safety communication because they feel more dedicated and less fatigued. Figure 1 summarizes the proposed model.

This study makes four primary contributions to the crew rostering literature. First, we extend research on the individual effects of crew rostering by examining how rostering policies shape flight crew safety behaviours, moving beyond the predominant focus on fatigue and sleep to capture

[1]Throughout the manuscript, we use *roster* to refer to the assigned work schedule itself, *rostering* to refer to the specific policy regime in which schedules are primarily assigned by management, and *crew rostering policy* (or policy regime) to refer more broadly to the organizational system through which rosters are allocated.

behavioural and performance consequences. Second, we advance theory by clarifying the psychological mechanisms by which rostering policies shape safety outcomes. By integrating COR theory (Hobfoll, 2011) with the JD–R model (Bakker et al., 2023; Demerouti et al., 2001), we conceptualize rostering policies as organizational conditions that shape employees' resource environments and specify dedication and fatigue as two complementary pathways linking these policy conditions to safety behaviours. Third, we advance a resource-based view of scheduling by conceptualizing crew rostering policies as proactive job-design features (Bakker & Demerouti, 2024) that shape the demand–resource balance through the scheduling system itself, and not only through task content (Demerouti, 2025). Consistent with COR theory, these policies operate as resource passageways that either protect or erode crews' resource reservoirs by structuring exposure to duty demands and access to recovery. In turn, greater crew participation in work-allocation functions as a job resource that helps align demands with individual constraints and mitigates fatigue (Liu et al., 2023; Wang et al., 2023). Finally, from a methodological perspective we employ a robust dual-study approach, combining a vignette experimental design with a time-lagged panel design, to provide comprehensive evidence for our theoretical model. This multi-method approach enhances the validity and generalizability of our findings while addressing limitations inherent to single-method studies common in this field.

Crew rostering policies

As noted, crew rostering is a critical component of airlines' crew scheduling process, allocating work assignments to individual crew members (Ernst et al., 2004). Airlines must balance cost control and efficient crew utilization (Lučić & Teodorović, 2007) with crew satisfaction and well-being (Quesnel et al., 2020), a trade-off that creates complex operational constraints and has led airlines to adopt different rostering policies.

The literature typically distinguishes three rostering policies: bidline, rostering and personalized roster policies. They differ in how much influence individual crew members have over their final schedules (e.g., de Armas et al., 2017; Deveci & Demirel, 2018; Gamache et al., 1998). The *bidline* policy is a two-stage approach in which airlines first create generic schedules covering all flight pairings without assigning specific crew members. Employees then 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). Although this policy provides complete visibility into available assignments (Kohl & Karisch, 2004), it limits employees' ability to shape their schedules because they must choose from predetermined options.

Under the *rostering policy* airlines generate individualized schedules for each crew member but typically allow limited opportunity to submit personal requests (e.g., specific days off or preferred activities) (de Armas et al., 2017). Adjustments are possible, but mainly through swaps among coworkers. A variation of this model, fixed rostering, uses predetermined patterns of work and off days that remain constant over time (Maenhout & Vanhoucke, 2011; Meskanen, 2024). This method is commonly used by some low-cost carriers (e.g., Ryanair) and offers predictable routines, such as five days on followed by four days off, which pilots value because it provides a greater sense of control over their professional lives (Efthymiou et al., 2021).

Finally, *personalized rostering* incorporates individual crew preferences before monthly schedules are generated. Preferences are collected through a bidding process in which employees submit specific requests, including particular pairings, rest periods and destination preferences or avoidances (Achour et al., 2007; de Armas et al., 2017; Gamache et al., 1998). Although the final roster may remain uncertain because airlines must meet operational demands (Abdelghany & Abdelghany, 2016; Badánik et al., 2021), employees' preferences are treated as key inputs.

This study addresses two of these policies, rostering and personalized rostering, because they capture the predominant crew rostering methods employed by contemporary commercial airlines.

TABLE 1 Different bidding policies between studied crew rostering approaches.

		Personalized rostering	
	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

Note: This table demonstrates the ability a crew member has to express their requests and consequently influence their monthly roster on two approaches (Rostering and Personalized Rostering) mentioned in this paper.
Abbreviation: PBS, preferential bidding system.

Although the bidline system holds historical importance, it does not accommodate flight crew members' ability to influence their work schedule. Moreover, given that personalized rostering encompasses various configurations of the bidding process (i.e., 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 resides in the scope of requests available to crew members. Simple bidding restricts requests to fundamental scheduling elements: days off and pairing assignments. In contrast, advanced bidding adds to these basic options to provide a broader range of requests (e.g., the ability to prioritize or avoid certain destinations, specify preferred sign-on and sign-off times), resulting in a more customized schedule. Table 1 summarizes the three crew policies addressed herein.

Crew rostering policies as resource caravan passageways

Flight crew work offers a unique occupational context characterized by exceptional demands that create intense resource depletion patterns (Grant et al., 2024). Crew members must maintain near-perfect error rates under high-stakes conditions while managing irregular schedules, extended duty periods and emotional labour from passenger interactions across multiple time zones (Chen & Chen, 2014; O'Neil & Krane, 2012). This demanding work requires crew members to continuously mobilize physical, cognitive and emotional capacities to sustain performance and cope with occupational stressors, creating cycles of depletion and replenishment that shape how they experience work and respond to 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. The 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). Importantly, COR theory recognizes that resources exist within ecological systems in which organizational structures and policies shape the trajectories of resources over time (Hobfoll et al., 2018). This resource-centred lens allows us to reconceptualize crew rostering policies not only as administrative procedures but also as what COR theory terms resource caravan passageways.

According to the COR theory, resource caravan passageways are the environmental or organizational conditions that shape resource trajectories, including whether resources are more likely to accumulate, be protected or be depleted over time (Halbesleben et al., 2014; Hobfoll et al., 2018). These passageways 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). In this sense, crew rostering policies function as relatively enduring organizational mechanisms that structure the resource ecology in which flight crews work, thereby influencing whether the scheduling environment becomes resource-enriching or resource-depleting. As institutional passageways, rostering policies also structure the temporal architecture of work (e.g., the timing and sequencing of duties, the distribution of rest periods and roster predictability), thereby shaping resource protection versus accelerated depletion. This framing aligns with recent COR applications that conceptualize organizational HR policies and systems as passageways through which valued personal resources can be nurtured (e.g., Fletcher & Lysova, 2025; Mansour & Tremblay, 2018).

In the aviation industry, crew members' ability to influence their work schedules emerges as a salient route through which work-life balance, schedule predictability and psychological well-being can be supported or undermined (Lučić & Teodorović, 2007; Wen, 2024). Accordingly, scheduling systems that expand crew influence are associated with stronger performance and lower burnout by supporting access to and preservation of key resources (Efthymiou et al., 2021; Grant et al., 2024).

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 expand crew members' perceived control and participation in work allocation, enabling 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 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 in which schedule unpredictability undermines sleep quality, family relationships and personal well-being, ultimately compromising job performance and organizational outcomes. Consistent with COR theory, these divergent passageways should translate into different downstream patterns of resource gain versus loss: facilitative policies make it easier to conserve and build resources, whereas constrained policies increase exposure to demands and accelerate depletion (Hobfoll, 2011; Hobfoll et al., 2018).

Autonomy and inclusion in decision-making as passageway characteristics

Building on the resource caravan passageways framework, we argue that the three crew rostering policies examined in this paper (rostering, simple preferential bidding and advanced preferential bidding) constitute distinct organizational passageways that differ in the autonomy and inclusion in decision-making they afford flight crews. Our focus on these two constructs is theoretically grounded in the work design and perceived control literature, which treats autonomy and participation in decision-making as core, proximal features through which work systems structure employees' influence over their work (Morgeson & Humphrey, 2006; Spector, 1986). This is also consistent with recent applications of COR theory that distinguish passageway conditions from the more proximal resource processes they enable, positioning contextual features of the work system as the passageway itself (Fletcher & Lysova, 2025). These features are particularly appropriate for capturing passageway characteristics, because they reflect how rostering systems are structured at the policy level, whereas other constructs may be better understood as more evaluative downstream appraisals of these policy features (e.g., fairness perceptions; Colquitt, 2001).

These two dimensions are the core policy features through which each rostering-system structures crew members' access to resources, shaping whether the scheduling context becomes more resource-enriching or resource-depleting. 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 is a defining characteristic of rostering passageways as it reflects an intrinsic job-design feature tied to job content (Mehmood et al., 2026), namely how much control employees have over their immediate work processes and scheduling environment (Dettmers & Bredehöft, 2020). Inclusion in decision-making is complementary but theoretically distinct because it operates at a different organizational level. Unlike autonomy's intrinsic focus on individual schedule control, inclusion is an extrinsic dimension that captures employees' participation in wider managerial and organizational decisions (Stiglbauer & Kovacs, 2018). It reflects participative decision-making philosophies and culture, rather than task-specific job design (Stiglbauer & Kovacs, 2018). More specifically, inclusion reflects the extent to which employees are consulted, heard and considered in decisions that shape work arrangements and affect multiple employees (Nishii, 2013). In all, autonomy concerns control over one's own work schedule, whereas inclusion concerns being consulted and taken into account in decisions that shape work allocation more broadly.

These two dimensions create distinct passageway profiles across the three rostering policies. *Rostering* constitutes a restrictive resource caravan passageway, with minimal autonomy and inclusion because schedules are built without crew input, limiting access to schedule-control and work–life balance resources (de Armas et al., 2017). *Simple preferential bidding* is moderately facilitative, granting some autonomy and inclusion through basic preference expression, such as preferred pairings or days off. *Advanced preferential bidding* is highly facilitative, combining high autonomy and inclusion by allowing extensive and combinable requests, thereby maximizing crew access to resources (Kohl & Karisch, 2004). Therefore, we propose:

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

Effects on flight crew levels of fatigue and dedication

The resource caravan passageways shape the ecological conditions that determine how well individuals can acquire and preserve resources (Hobfoll et al., 2018). Applied to crew rostering, this implies that differences in passageway characteristics, specifically the autonomy and inclusion they provide, should influence the extent to which flight crews can build and sustain their resource levels (Hobfoll, 2011). Importantly, COR theory posits that resource loss is psychologically more salient than comparable resource gain (Hobfoll et al., 2018). Thus, facilitative passageways should be experienced not only as more favourable conditions for resource preservation and accumulation but also as reduced exposure to loss, which may trigger resource gain spirals in which job resources enable further resource accumulation (Chen & Chen, 2014).

Whereas COR theory offers these foundational principles, it is often less explicit about the mechanisms linking resource conditions to concrete psychological states (Demerouti, 2025; Fletcher & Lysova, 2025). To specify these pathways, we draw on the JD–R model to theorize how resource conditions translate into employee states by distinguishing two additive processes with separate main effects (Gonzalez-Mulé et al., 2021): a health-impairment process, activated when demands require sustained extra effort and erode health over time (Li et al., 2013) and a motivational process, activated when resources are perceived as available and support stronger engagement (Demerouti et al., 2019; Hakanen & Roodt, 2010). We operationalize these processes as fatigue and dedication, respectively. 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), is a central health-impairment outcome in aviation. It is widely recognized as a critical issue by both aviation scholars (Bendak & Rashid, 2020; Lee & Kim, 2018; Lin et al., 2024) and professional entities (IATA, 2025), and prior work links scheduling practices to fatigue levels (Lee & Kim, 2018). Regarding the motivational process, we focus on dedication, the emotional core of work engagement, reflected in meaning, enthusiasm, inspiration and pride (Sinval et al., 2018). Dedication is also theoretically foundational, in that it is often viewed as a prerequisite for other engagement components such as vigour and absorption (Kuntsi, 2014), making it an appropriate indicator of the motivational pathway expected under facilitative rostering passageways.

In integrating COR theory with the JD–R model, we propose that *advanced preferential bidding* policies create more facilitative resource caravan passageways than do rostering and simple preferential bidding. According to COR theory, the autonomy and inclusion embedded in advanced policies reflect defining passageway characteristics that shape how easily crew members can access and protect valued resources. Scheduling autonomy supports predictability and reduces depletion by helping crews align duty demands with personal constraints and recovery needs, whereas inclusion signals voice and organizational support, strengthening protection against resource loss threats (Hobfoll et al., 2018). Together, these conditions may reduce vulnerability to resource loss and initiate gain spirals in resource-rich environments (Chen & Chen, 2014). From a JD–R perspective, these more favourable conditions should activate the motivational process and dampen the health-impairment process. Thus, autonomy and inclusion should increase dedication by enabling crews to meet demands effectively and experience work as more meaningful (Hakanen & Roodt, 2010), while lowering fatigue by restraining depletion cycles that require sustained compensatory effort (Li et al., 2013; Lin et al., 2024). This aligns with evidence 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). Comparatively, *rostering* and *simple preferential bidding policies* create more restrictive resource caravan passageways than *advanced preferential bidding policies*, thereby establishing more resource-poor ecological conditions. By limiting autonomy and inclusion, these policies are more likely to sustain fatigue and constrain conditions that foster dedication. This is consistent with fatigue risk management systems research emphasizing that poorly designed rosters contribute to fatigue accumulation and impaired cognitive functions (IATA, 2025; Lin et al., 2024; Wen, 2024).

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

Effects on flight crew safety behaviours

The psychological outcomes established in our hypotheses above have important implications for safety behaviours. Although safety behaviour was initially framed mainly as compliance with prescribed routines, more recent work in the aviation field distinguishes multiple forms of safety behaviour (Chen & Chen, 2014; Fugas et al., 2012). Chen and Chen (2014) differentiate between in-role safety behaviours, defined as compliance with safety procedures and standard operational protocols; extra-role safety behaviours, which involve discretionary actions that go beyond formal requirements (e.g., assisting coworkers and supporting safety initiatives); and upward safety communication, which captures willingness to report concerns, share observations and propose recommendations to improve safety performance.

Fatigue and dedication are especially consequential for these behaviours because they represent, respectively, a health-impairment pathway and a motivational pathway with direct implications for safe performance. Fatigue undermines sustained attention, memory and self-regulation, increasing lapses in procedural compliance (in-role safety), reducing the effort available for discretionary helping and safety initiatives (extra-role safety) and diminishing the capacity to monitor the environment and speak up about emerging risks (upward safety communication) (Chen & Chen, 2014; IATA, 2025; Kandera et al., 2019; Wen, 2024). Dedication, in turn, is a motivationally driven facet of contextual performance reflected in persistence, proactive initiative and adherence to organizational rules (Van Scotter & Motowidlo, 1996). Thus, it promotes conscientious enactment of mandatory procedures (in-role safety), willingness to invest extra effort in supporting colleagues and improving safety (extra-role safety) and stronger identification with the organization that encourages proactive upward safety communication (Chen & Chen, 2014; Khushnood et al., 2020).

Scheduling autonomy allows crew members to align duty demands with personal constraints, circadian rhythms and recovery needs, supporting more sustainable work–rest cycles (Knudsen et al., 2007). Accordingly, greater scheduling autonomy should be associated with lower fatigue, which should support consistent adherence to procedures (in-role safety), preserve capacity for discretionary helping and safety initiative support (extra-role safety) and sustain attentional resources and vigilance needed to identify and communicate emerging risks (upward safety communication) (IATA, 2025; Lin et al., 2024; Liu et al., 2023; Wang et al., 2023; Wen, 2024). Autonomy may also strengthen dedication by increasing experienced agency and meaningfulness, as greater control over core aspects of work design tends to foster intrinsic motivation and engagement (Hackman & Oldham, 1976; Schaufeli & Salanova, 2007). In turn, greater dedication should translate into stronger safety performance across in-role compliance, extra-role contributions and upward safety communication (Nahrgang et al., 2011).

Furthermore, inclusion in decision-making should reduce strain and powerlessness when consequential work conditions are imposed without employee input (Merlini et al., 2019; Wen, 2024). Therefore, greater perceived inclusion should be associated with lower fatigue, thereby supporting fewer lapses in safety compliance (in-role safety), greater capacity for discretionary safety contributions (extra-role safety) and improved readiness to raise safety concerns (upward safety communication). Inclusion should also strengthen dedication by signalling respect, voice and organizational support, thereby promoting a more organizationally grounded sense of commitment and involvement (Le et al., 2021). In turn, greater dedication should encourage conscientious enactment of mandatory procedures (in-role safety), voluntary effort directed at safety improvement (extra-role safety) and proactive upward communication of risks and recommendations (upward safety communication). Thus, we propose:

> **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).

OVERVIEW OF THE STUDIES

We conducted two studies to test our research model. Study 1—an experimental vignette methodology (Aguinis & Bradley, 2014)—examines whether different crew rostering policies (rostering, simple preferential bidding and advanced preferential bidding) are associated with distinct levels of autonomy and inclusion (H1) and whether they affect 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). The purpose of Study 2 is 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), we conducted a time-lagged panel design with a sample of flight crew members (pilots and cabin crews), 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, we 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 1 consolidates the hypothesized relationships and situates them within our two-study design.

STUDY 1: METHODOLOGY

Sample and procedures

We recruited participants through Prolific platform (http://prolific.ac) due to its superior data quality (Peer et al., 2022), between May and June 2024. We restricted our search to participants who were pilots and cabin crew, to assure familiarity with the scenario (Podsakoff & Podsakoff, 2019). As a second verification check, we included a question in the survey asking if the participant was working as a pilot or cabin crew at the time of the study. Participants received a compensation of approximately £.71[2] for their participation. We considered only participants who met the above screening criteria, 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 confirmed that were working as flight crew at the time of the study. We were able to collect 160 responses. As for the demographics: 56.9% identified as male, the age average was 33.78 years ($SD = 9.42$; min = 20; max = 66) and 71.3% were cabin crew. Regarding educational level, 28.9% had completed high-school, 53.9% college and 17.1% a master's degree or higher. Considering 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. We did not ask respondents to identify the specific airline for which they were working at the time of the study, because this is sensitive information that could deter participation and compromise data quality (Tourangeau & Yan, 2007). We did, however, ask respondents to indicate the country in which their current employer was based. The majority of participants (51%) were working for airlines based in Europe (e.g., United Kingdom, Portugal), 40.3% for airlines based in North America (e.g., USA, Canada), 5.4% in South Africa, 2.7% in Australia and .7% in the United Arab Emirates.

We developed three hypothetical scenarios, each describing the main characteristics of each crew rostering policy targeted in our study: rostering, simple preferential bidding and advanced preferential bidding. We essentially manipulated the rostering-policy regime rather than specific objective scheduling features. Accordingly, each scenario[3] varied the degree to which crew members could submit requests (bidding) and participate in work-allocation decisions. We instructed participants to imagine the described scenario as vividly as possible. To enhance perception and realism, we incorporated images and the layout of the airline's scheduling software currently available on the market (scenarios available in Appendix S1). Participants were randomly assigned to only one of each experimental condition, thereby minimizing primacy and tiredness effects of being exposed to multiple experimental conditions (Auspurg & Jäckle, 2017), which could confound the results. They were instructed to imagine themselves working as flight crew (either 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 aircraft. With 30 years of existence, they've shown strong resilience in a competitive market with stable grow throughout the years".

In the *rostering condition*, participants were instructed that they could not request any specific activities (either flights or days off) and the only mechanism for obtaining a particular day off or flight assignment was through swapping with colleagues. Under this policy, the airline's scheduling department maintains complete control over flight crew rosters. In the *simple preferential bidding* condition participants were informed that they could request up to four pairings, ranked in order of priority, with the restriction that

[2]We set compensation using Prolific's built-in pricing tool, specifying a target hourly rate of £8.52/hr and an expected completion time of 5 min. After data collection, Prolific recalculated the effective rate using the median completion time (5:29 min), yielding a median-based payment rate of £7.77/hr, which exceeds Prolific's minimum pay standard (≥£6/hr). This approach is consistent with Prolific's emphasis on transparent, time-based minimum compensation, and clear participant rights and procedures, which helps support ethical practice and reduces concerns common on other crowdworking platforms (e.g., underpayment and related data-quality or demand effects; Palan & Schitter, 2018).

[3]The scenarios were developed based on the descriptions of each crew rostering process available in the literature (e.g., Achour et al., 2007; Barnhart, 2009; Efthymiou et al., 2021; Gamache et al., 1998; Kinnunen, 2015; Kohl & Karisch, 2004; Le Duc & Badánik, 2021; Maenhout & Vanhoucke, 2011; Meskanen, 2024; Wen, 2024) as well as in the technical description of the functioning of each system (Jeppesen, 2024; Navblue, 2024).

only one request would be fulfilled in the following monthly roster. Additionally, crew members could 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, meaning that if two employees request the same activity, priority would be given to the most senior one. Finally, in the *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 the organization would accommodate these preferences to the maximum extent possible. As with the *simple preferential bidding condition*, the assignment of these requests remains contingent upon the individual's seniority within the airline.

After reading the conditions, participants rated the level of autonomy and inclusion felt from using that crew scheduling policy. We then asked them to imagine working for that airline and rate their levels of dedication and fatigue.

Instruments

We used well-established measures to collect data. Whenever possible, we opted to use short versions of each scale to enhance the efficiency of our surveys and mitigate potential biases due to fatigue or lack of attentiveness (Hamaker, 2023). All measures were rated using a Likert scale ranging from 1 = strongly disagree to 7 = strongly agree.

Autonomy

We used the three original items from the scale advanced by (Breaugh, 1999). The items were slightly modified to align with the context of flight crews' work particularities. Also, we added an item to address the flight crew's ability to choose activity locations (where). 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". (Reliability: $\alpha = .93$; $\omega = .95$).

Inclusion in decision making

We used the items developed by (Nishii, 2013). Six out of the eleven original items were retained. We adjusted the wording of the items to reflect inclusion regarding the scheduling system. Sample items are: "This is a rostering system in which employees make use of their knowledge to enhance their work" and "In this scheduling system, employee input is actively sought". (Reliability: $\alpha = .94$; $\omega = .95$).

Fatigue

We measured fatigue using the eight items from the Copenhagen Burnout Inventory (CBI) (Kristensen et al., 2005). We modified the verb tenses to ensure appropriate contextual interpretation. For instance, an 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. (Reliability: $\alpha = .97$; $\omega = .98$).

Dedication

We used the three items of the Utrecht Work Engagement Scale (Schaufeli & Bakker, 2003). We modified only the verbs to ensure appropriate contextual interpretation. For example, an item was adapted from "My job inspires me" to "I would feel inspired in this job". (Reliability: $\alpha = .89$; $\omega = .95$).

Control

Following Bernerth and Aguinis' (2016) recommendations, we included only control variables with established theoretical rationale and empirical evidence of relationships with our outcomes variables to avoid artefacts from over controlling. We controlled for work experience as a pilot/cabin crew (measured in years) because more experienced flight crew members may have encountered a wider range of rostering systems and worked under different bidding policies, which could shape their perceptions and responses to our scenarios. Work experience serves as a reasonable proxy for exposure to and familiarity with organizational procedures such as rostering practices (e.g., Godfroid et al., 2022; Tesluk & Jacobs, 1998).

Analytical strategy

We used ANCOVAs to test Hypotheses 1 and 2 because both hypotheses concern mean differences across the three experimental conditions on each outcome while adjusting for a covariate (i.e., work experience). ANCOVA is well suited to this as it estimates means for each condition and tests whether conditions differ after accounting for the effect of control variable (Tabachnick & Fidell, 2019). We ran two separate ANCOVAs per hypothesis (H1a: autonomy; H1b: inclusion; H2a: fatigue; H2b: dedication) because each outcome is a distinct dependent variable, and ANCOVAs provide a parsimonious and directly interpretable test (Tabachnick & Fidell, 2019). Given three experimental conditions, we conducted Tukey-adjusted pairwise comparisons of the estimated marginal means (covariate-adjusted means) following the ANCOVA to identify which conditions differed while controlling the error rate across the three pairwise tests (Maxwell et al., 2017). We performed our analysis using R software (version 4.5.1). Following Becker et al. (2016), we ran all analyses with and without this control and the results were unchanged. We report results that include the control variable.

STUDY 1: RESULTS

Bivariate correlations, descriptive statistics and reliabilities are reported in Table 2.

Manipulation checks and Hypothesis 1

Participants rated autonomy higher in the advanced preferential bidding condition (M=5.21, 95% CI [4.88, 5.53]) than in the simple preferential condition (M=4.10, 95% CI [3.77, 4.43]) and the rostering condition (M=2.16, 95% CI [1.83, 2.49]). The results revealed that these differences were statistically significant: $F(2, 156)=86.71$, $p<.001$; $\eta p^2=.54$. Tukey-adjusted pairwise comparisons indicated that all conditions differed, with confidence intervals excluding zero (rostering vs. simple preferential: $\Delta M=-1.94$, 95% CI [−2.50, −1.38]; rostering vs. advanced preferential bidding: $\Delta M=-3.05$, 95% CI [−3.60, −2.49]; and simple preferential vs. advanced preferential bidding: $\Delta M=-1.10$, 95% CI [−1.66, −.55]). Similarly, participants rated inclusion in decision-making higher in the advanced preferential bidding condition (M=5.08, 95% CI [4.77, 5.40]) than in the simple preferential condition (M=4.35, 95% CI [4.03, 4.67]) and the rostering condition (M=2.45, 95% CI [2.13, 2.77]). The results demonstrated that these differences were statistically significant: $F(2, 156)=70.31$, $p<.001$; $\eta p^2=.49$. Tukey-adjusted pairwise comparisons again showed that all conditions differed, with confidence intervals excluding zero (rostering vs. simple preferential: $\Delta M=-1.90$, 95% CI [−2.45, −1.36]; rostering vs. advanced preferential bidding: $\Delta M=-2.63$, 95% CI [−3.17, −2.09]; and simple preferential vs. advanced preferential bidding: $\Delta M=-.73$, 95% CI [−1.27, −.19]). Taken together, these results support the effectiveness of our manipulation and provide support to Hypothesis 1, where we assumed that

TABLE 2 Descriptive statistics, reliabilities and zero-order correlations (Study 1; $N=160$ flight crew).

	Mean	*SD*	1	2	3	4	5	6	7	8	9
1. Autonomy	3.84	1.72	(.93)								
2. Inclusion	3.99	1.59	.85**	(.94)							
3. Fatigue	4.00	1.52	−.62**	−.70**	(.96)						
4. Dedication	4.46	1.40	.70**	.74**	−.69**	(.89)					
5. Age	33.78	9.42	.11	.03	−.09	−.00	–				
6. Gender	–	–	−.14	−.08	.15	−.08	−.16	–			
7. Work experience	7.13	7.12	.00	−.07	.03	−.06	.74**	−.09	–		
8. Occupation	–	–	−.02	.04	.13	−.03	−.05	.32**	−.10	–	
9. Type of operation	–	–	.06	.04	.02	.08	.17*	.11	.19*	.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.
*$p<.05$; **$p<.01$.

advanced preferential bidding policies should be associated with higher levels of autonomy (H1a) and inclusion in decision-making (H1b) than rostering and simple preferential bidding policies.

Effects on fatigue and dedication

In Hypothesis 2 we argued that advanced preferential bidding policy should be associated with lower levels of fatigue (H2a) and higher levels of dedication (H2b) than rostering and simple preferential bidding policies. The overall effect of condition on fatigue was statistically significant, $F(2, 148)=21.06$, $p<.001$; $\eta p^2=.23$. The results showed that participants in the advanced preferential bidding condition reported lower fatigue ($M=3.40$, 95% CI [3.02, 3.77]) than those in the rostering condition ($M=5.04$, 95% CI [4.66, 5.43]), and this difference was supported by Tukey-adjusted comparisons ($\Delta M=1.65$, 95% CI [1.00, 2.29]). However, fatigue did not differ between the advanced preferential bidding and simple preferential conditions ($M=3.64$, 95% CI [3.25, 4.02]; $\Delta M=.24$, 95% CI [−.40, .89]). Similarly, participants in the advanced preferential bidding condition reported greater dedication ($M=4.94$, 95% CI [4.63, 5.25]) than those in the rostering condition ($M=3.17$, 95% CI [2.85, 3.48]), and this difference was significant ($\Delta M=-1.77$, 95% CI [−2.30, −1.24]). In contrast, dedication did not differ between the advanced preferential bidding and simple preferential conditions ($M=4.60$, 95% CI [4.29, 4.92]; $\Delta M=-.33$, 95% CI [−.86, .19]). Consistent with our expectations, the overall effect of condition on dedication was statistically significant, $F(2, 148)=35.42$, $p<.001$; $\eta p^2=.32$. However, Tukey-adjusted comparisons indicated that the advanced preferential bidding condition differed from rostering, but not from simple preferential bidding, yielding partial support for Hypothesis 2.

We also investigated if the condition effects on fatigue and dedication were statistically consistent with indirect effects via perceived autonomy and inclusion. Because the mediators (autonomy and inclusion) and the outcomes (fatigue and dedication) were measured in the same survey session, these analyses should be interpreted as evidence consistent with the proposed process rather than as definitive causal tests of the full mediation chain (Podsakoff & Podsakoff, 2019; Spencer et al., 2005). Accordingly, we conducted post hoc mediation analyses[4] to see if the experimental scenarios influenced fatigue and ded-

[4]We conducted a confirmatory factor analysis (CFA) to test the distinctiveness of the constructs. The hypothesized four-factor model (autonomy, inclusion, fatigue, and dedication) showed good fit, χ^2 (183)=234.20, CFI=1.00, TLI=1.00, RMSEA=.04, SRMR=.04. A three-factor model collapsing autonomy and inclusion fit significantly poorer than the four-factor model ($\Delta\chi^2$ (3)=45.11, $p<.001$), supporting discriminant validity between autonomy and inclusion. The one-factor model also fit significantly poorer than the four-factor solution ($\Delta\chi^2$ (6)=220.06, $p<.001$). Detailed information is found in Appendix S2.

ication through perceived autonomy and inclusion in decision making. We first treated the experimental condition as a three-level categorical predictor (rostering, simple preferential bidding, advanced preferential bidding), using "rostering" as the reference condition, and estimated indirect effects with bias-corrected bootstrapped confidence intervals (20,000 resamples). The results showed that compared with rostering, simple preferential bidding had a significant total indirect effect on dedication through autonomy and inclusion (estimate = 1.26, 95% CI [.926, 1.654]) and a significant total indirect effect on fatigue (estimate = −1.42, 95% CI [−1.879, −1.013]). Likewise, advanced preferential bidding (vs. rostering) showed a significant total indirect effect on dedication (estimate = 1.74, 95% CI [1.322, 2.234]) and on fatigue (estimate = −1.95, 95% CI [−2.518, −1.438]). Given our theoretical argument that the scenarios reflect increasing levels of rostering-policy sophistication (rostering < simple preferential bidding < advanced preferential bidding), we also tested a linear "dose–response" specification by treating the condition as an ordered predictor (1–3) (Tabachnick & Fidell, 2019). This analysis indicated that each one-step increase in crew rostering-policy sophistication indirectly increased dedication via greater autonomy and inclusion (total indirect effect per step: estimate = .88, 95% CI [.669, 1.132]) and indirectly reduced fatigue (estimate = −.983, 95% CI [−1.265, −.729]). These results are statistically consistent with the indirect pathway via perceived autonomy and inclusion, offering preliminary evidence for the theorized process.

STUDY 2: METHODOLOGY

Sample and procedures

We collected data for Study 2 through several sources. First, we drew on contacts from the second author of this study (a pilot for a European commercial airline). We also disclosed our study through several professional and social channels, including LinkedIn, WhatsApp groups, Facebook and international flight crew unions, thereby ensuring global reach and a wide spectrum of participants. At Time 1 (T1) we collected data from July 2024 to October 2024 using an online survey (in English, the official language in aviation) created on the Qualtrics platform. During this period, a total of 585 participants opened the link and started filling in the survey. We deleted 177 surveys due to incompletion or failure to our attention checks, leaving a sample of 408 participants in T1. We asked participants to provide an email to receive the second survey one month later. We assured participants that their emails were only to pair their answers from both surveys. We assured them that confidentiality was guaranteed and we would delete their emails after pairing the responses.

At Time 2 (T2), which occurred one-month after T1—that is, between August 2024 and September 2024—we sent the second survey to our T1 sample at the email provided by them in the first survey. After two friendly reminders we were able to pair 230 responses. We deleted 9 surveys due to failure in attention checks, yielding a final sample of 221 participants who responded to both surveys. Regarding jobs and ranks, 103 were cockpit crew (of which 62.1% were first officers) and 118 cabin crews (of which 36.2% were not pursers or cabin supervisors). One participant opted not to reveal their gender, and 118 were male participants (53.4%). The age average was 37.78 years (SD = 8.92; min = 22; max = 62) and 53.39% 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. The majority of participants (86.4%) were working for airlines based in Europe (e.g., Portugal and United Kingdom), 8.1% for airlines based in Asia (e.g., United Arab Emirates, Qatar), 4.1% for airlines based in North America (e.g., United States, Canada) and .5% each for airlines based in Africa (Tunisia), Oceania (New Zealand) and South America (Brazil).

Instruments

Our T1 survey measured autonomy (α = .86; ω = .88), inclusion in decision-making (α = .87; ω = .87), fatigue (α = .91; ω = .91) and dedication (α = .90; ω = .92) using the same items used in Study 1. The T2 survey measured safety behaviours using the measure used by Chen and Chen (2014). Participants were instructed to focus on their safety behaviours over the last month and rated all items on a seven-point Likert scale (1 = strongly disagree to 7 = strongly agree).

In-role safety behaviour

All original items (3) were retained, with modifications made only to verbs to ensure appropriate contextual interpretation. For instance, an 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". (Reliability: $\alpha = .76$; $\omega = .84$).

Extra-role safety behaviour

Two original items were retained with minor modifications to include both pilots and cabin crew. Sample items are: "I promote safety programs within the organization" and "I put in extra effort to improve the safety on board". (Reliability: $\alpha = .67$; $\omega = .73$).

Upward safety communication

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". (Reliability: $\alpha = .87$; $\omega = .90$).

Control variables

We follow the same rationale as in Study 1 and also controlled for work experience (measured in years). Meta-analytic evidence shows that work experience is reliably associated with work performance (e.g., Quińones et al., 1995; Van Iddekinge et al., 2019).

Analytical strategy

To test Hypotheses 3 and 4 we estimated a structural equation model in R (version 4.5.1) using the *lavaan* package (Rosseel, 2012). Because our model includes two predictors, two mediators and three outcomes, we used composite indicators rather than modelling all constructs as latent variables. This approach yields a more parsimonious model with fewer free parameters, which can improve estimation stability and reduce the risk of overfitting when sample size is modest relative to model complexity (Kline, 2012; Rosseel, 2012). Using composite indicators is also appropriate when the measures' psychometric adequacy has already been established via confirmatory factor analyses (Available in Appendix S2), allowing the structural tests to proceed without estimating a highly parameterized latent measurement model (Hair et al., 2020). Indirect effects were evaluated using 20,000 bootstrap resamples to construct confidence intervals, consistent with recommendations to use bootstrapping for mediation because the sampling distribution of indirect effects is often non-normal (Hayes, 2012; MacKinnon et al., 2004). We ran all analyses in both studies with and without this control and the results were unchanged. We therefore report results that include the control variable (Becker et al., 2016). For ease of interpretation, we report standardized coefficients (β) for the structural paths.

Measurement model and discriminant validity

We conducted a confirmatory factor analysis (CFA) to test the distinctiveness of the constructs. Following recommended practices for transparency in CFA reporting (Cortina et al., 2017), we confirm that the model was specified with items loading only on their intended factors, and we did not introduce post hoc modifications based on modification indices (e.g., correlated residuals or cross-loadings). Using the cutoff values (i.e., SRMR ≤ .08, RMSEA ≤ .06, and CFI ≥ .96) proposed by Hu and Bentler (1998, 1999) the hypothesized seven-factor model showed good fit: $\chi^2(443) = 572.42$, $p < .001$, CFI = .97, TLI = .97, RMSEA = .05 (90% CI [.044, .058]) and SRMR = .05, with generally substantial standardized loadings from .59 to .92. Nested model comparisons (Table 3) indicated that collapsing constructs into fewer factors significantly worsened model fit at each step (scaled $\Delta\chi^2$ tests, $p < .001$).

We also examined convergent and discriminant validity using reliability and variance-extraction indices. As shown previously, internal consistency was "acceptable" to "excellent" across constructs. Convergent validity was also supported, with Average Variance Extracted (AVE) values exceeding the .50 criterion (Fornell & Larcker, 1981): autonomy = .72, inclusion = .59, fatigue = .60, dedication = .79, in-role safety = .64, extra-role safety = .53 and upward safety communication = .65. Discriminant validity was supported by the Fornell–Larcker criterion (Fornell & Larcker, 1981): the square roots of AVE (.73–.89) exceeded the corresponding inter-construct correlations, whose largest absolute value was .58. Finally, due to the strong correlation between our predictors (autonomy and inclusion), we examined for multicollinearity using variance inflation factors (VIFs). Results indicated no evidence of problematic multicollinearity: VIFs were approximately 1.51–1.52. These values are well below commonly used thresholds (e.g., VIF > 5; Hair et al., 2019), suggesting that collinearity should not be a concern.

STUDY 2: RESULTS

Bivariate correlations, descriptives and reliabilities are reported in Table 4.

Hypotheses testing

The results are summarized in Table 5. In Hypothesis H3a we proposed that autonomy perceived from scheduling policies enhances in-role safety behaviours, extra-role safety behaviours and upward safety communication through reduced fatigue. The results revealed that autonomy was negatively related to fatigue ($\beta = -.25$, $SE = .08$, 95% CI [−.40, −.10]). In turn, fatigue was non-significantly associated with in-role safety behaviours ($\beta = -.02$, $SE = .09$, 95% CI [−.20, .16]) and extra-role safety behaviours ($\beta = .04$, $SE = .08$, 95% CI [−.12, .19]) but had a significant negative relationship with upward safety communication ($\beta = -.16$, $SE = .08$, 95% CI [−.31, −.01]). When examining the indirect effects of autonomy on safety outcomes through fatigue, we found a significant indirect effect only for upward safety communication ($\beta = .04$, $SE = .01$, 95% CI [.01, .09]). The indirect effects on in-role safety behaviours ($\beta = .01$, $SE = .03$, 95% CI [−.04, .06]) and extra-role safety behaviours ($\beta = -.01$, $SE = .02$, 95% CI [−.06, .03]) were non-significant. Thus, Hypothesis H3a was partially supported.

In Hypothesis H3b we predicted that autonomy enhances in-role safety behaviours, extra-role safety behaviours and upward safety communication through increased dedication. Consistent with theoretical expectations, the results revealed that autonomy was positively related to dedication ($\beta = .17$, $SE = .07$, 95% CI [.03, .31]). Furthermore, the results revealed that dedication was positively related to extra-role safety behaviours ($\beta = .27$, $SE = .09$, 95% CI [.10, .44]) and upward safety communication ($\beta = .22$, $SE = .08$, 95% CI [.07, .38]), whereas its relationship with in-role safety behaviours did not obtain statistical significance ($\beta = .19$, $SE = .11$, 95% CI [−.03, .40]). When examining the indirect effects of autonomy

TABLE 3 Descriptive statistics, reliabilities and zero-order correlations (Study 2; $N = 221$ flight crew).

	Mean	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Autonomy	2.77	1.43	(.86)												
2. Inclusion	3.23	1.29	.58**	(.87)											
3. Fatigue	3.74	1.18	−.35**	−.32**	(.91)										
4. Dedication	5.06	1.40	.37**	.44**	−.54**	(.90)									
5. In-role safey	6.56	.65	−.00	−.10	−.01	.17*	(.76)								
6. Extra-role safety	5.53	1.03	.14*	.15*	−.14*	.28**	.23**	(.67)							
7. Upward safety communication	5.06	1.32	.25**	.33**	−.34**	.39**	.11	.37**	(.87)						
8. Age	37.78	8.93	−.12	−.18**	−.16*	.06	.03	.14*	.12	–					
9. Gender	–	–	−.19*	−.06	.47**	−.19**	−.07	−.13*	−.16*	−.24**	–				
10. Children	–	–	.16*	.20**	.06	.04	.21	.02	.03	−.56**	.17*	–			
11. Occupation	–	–	.22**	.09	−.48**	.25*	.04	.08	.14*	.23**	.81**	−.21**	–		
12. Type of operation	–	–	−.24	−.03	.20	.04	−.04	−.06	.13	−.03	.07	.01	−.05	–	
13. Work experience	14.09	9.86	−.11	−.14*	−.03	−.03	.03	.16*	.02	.80**	−.15*	−.44**	.12	−.01	–

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.

$^{*}p < .05$; $^{**}p < .01$.

TABLE 4 Nested measurement model comparisons (Study 2).

Model	χ^2	Df	χ^2_{diff}	CFI	RMSEA
7-factor (hypothesized model)	572.42***	443	–	.97	.04
6-factor (autonomy and inclusion in decision-making collapsed into a single factor)	780.54***	449	54.39***	.95	.06
5-factor (fatigue and dedication additionally collapsed into a single factor)	1272.59***	454	111.06***	.94	.09
4-factor (extra-role safety and upward safety communication additionally collapsed into a single factor)	1547.21***	458	62.40***	.93	.10
3-factor (combined extra-role safety, upward safety communication and in-role safety into one factor, while retaining the autonomy/inclusion and fatigue/dedication combined factors)	1838.95***	461	52.18***	.93	.12
2-factor (combined autonomy, inclusion in decision making, fatigue and dedication into one factor and combined extra-role safety, upward safety communication and in-role safety into a second factor)	3599.41***	463	140.38***	.89	.18
1-factor (all items on a single common factor)	5729.84***	464	215.95***	.82	.23

Note: χ^2_{diff} refers to the scaled (robust) chi-square difference test for nested models under WLSMV (DIFFTEST approach, as implemented in lavaan).

Abbreviations: CFI, comparative fit index; Df, degrees of freedom; RMSEA, root mean square error of approximation.

***p<.001.

on safety outcomes through dedication, we found significant indirect effects for extra-role safety behaviours (β=.05, SE=.01, 95% CI [.02, .11]) and upward safety communication (β=.04, SE=.02, 95% CI [.01, .09]). The indirect effect on in-role safety behaviours via dedication did not obtain statistical significance (β=.03, SE=.02, 95% CI [−.01, .08]). Thus, Hypothesis H3b was partially supported.

Hypothesis H4a proposed that inclusion perceived from scheduling policies enhances in-role safety behaviours, extra-role safety behaviours and upward safety communication through reduced fatigue. As expected, inclusion was negatively related to fatigue (β=−.18, SE=.08, 95% CI [−.34, −.03]). However, the indirect effects of inclusion on in-role safety behaviours (β=.00, SE=.02, 95% CI [−.03, .05]), extra-role safety behaviours (β=−.01, SE=.02, 95% CI [−.05, .02]) and upward safety communication (β=.03, SE=.02, 95% CI [−.01, .07]) through fatigue were non-significant. Therefore, Hypothesis H4a was not supported.

Finally, in Hypothesis H4b we posited that inclusion enhances in-role safety behaviours, extra-role safety behaviours and upward safety communication through increased dedication. Consistent with expectations, inclusion was positively related to dedication (β=.35, SE=.10, 95% CI [.15, .55]). When examining indirect effects, we found a significant indirect effect of inclusion via dedication on extra-role safety behaviours (β=.09, SE=.03, 95% CI [.03, .16]) and upward safety communication (β=.08, SE=.03, 95% CI [.02, .14]). The indirect effect on in-role safety behaviours via dedication was not different from zero (β=.06, SE=.04, 95% CI [−.01, .14]). Thus, Hypothesis H4b was partially supported. Table 5 summarizes the results.

DISCUSSION

This research examined how crew rostering policies shape flight crew safety behaviours. Combining COR theory (Hobfoll, 2011; Hobfoll et al., 2018) with the JD–R model (Bakker & Demerouti, 2007), we conceptualized rostering policies as resource caravan passageways whose autonomy and inclusion features affect flight crew fatigue and dedication, with implications for safety behaviour. Study 1 showed

TABLE 5 Structural equation model results (Study 2).

	Mediators (T1)						Dependent variables (T2)								
	Fatigue			Dedication			In-role safety			Extra-role safety			Upward safety communication		
	β	*t*	95% CI	*β*	*t*	95% CI	*β*	*t*	95% CI	*β*	*t*	95% CI	*β*	*t*	95% CI
Controls															
Work experience	−.09	−1.13	[−.23, .06]	.04	.44	[−.12, .19]	.03	.51	[−.08, .14]	.18	2.50	[.04, .31]	.05	.73	[−.09, .19]
Main predictors															
Autonomy (T1)	−.25	−3.24	[−.40, −.10]	.17	2.30	[.03, .31]	−.08	−.90	[−.26, .10]	.05	.68	[−.10, .21]	.02	.26	[−.13, .17]
Inclusion (T1)	−.18	−2.30	[−.34, −.03]	.35	5.32	[.15, .55]	.01	.20	[−.12, .15]	.03	.37	[−.14, .20]	.17	2.25	[.02, .33]
Mediator															
Fatigue (T1)							−.02	−.22	[−.20, .16]	.04	.49	[−.12, .19]	−.16	−2.07	[−.31, −.01]
Dedication (T1)							.19	1.66	[−.03, .40]	.27	3.06	[.10, .44]	.22	2.79	[.07, .38]
R^2	.15			.22			.04			.11			.20		
Indirect effects															
H3a: Autonomy → Fatigue →							β = .01 95% CI [−.04, .06]			β = −.01 95% CI [−.06, .03]			**β = .04 95% CI [.01, .09]**		
H3b: Autonomy → Dedication →							β = .03 95% CI [−.01, .08]			**β = .05 95% CI [.02, .11]**			**β = .04 95% CI [.01, .09]**		
H4a: Inclusion → Fatigue →							β = .00 95% CI [−.03, .05]			β = −.01 95% CI [−.05, .02]			β = .03 95% CI [−.01, .07]		
H4b: Inclusion → Dedication →							β = .06 95% CI [−.01, .14]			**β = .09 95% CI [.03, .16]**			**β = .08 95% CI [.02, .14]**		

Note: N = 221. Values are standardized path estimates (β); CI = 95% bootstrap confidence interval (20,000 resamples); T1 = Time 1; T2 = Time 2 (one month after T1). Indirect effects shown in bold are significant.

that policies with more extensive bidding options (i.e., *advanced preferential bidding*) were associated with greater autonomy and inclusion, lower fatigue and greater dedication. Study 2 revealed more nuanced mediation patterns than hypothesized. For H3, perceived autonomy was positively associated with upward safety communication via both reduced fatigue and increased dedication and with extra-role safety behaviours via dedication only. For H4, perceived inclusion was positively associated with upward safety communication and extra-role safety behaviours via dedication only, with no fatigue-mediated indirect effects. Neither autonomy nor inclusion showed indirect effects on in-role safety behaviours through either pathway.

CONTRIBUTIONS TO THEORY

Our research makes several contributions. First, we extend research on the individual effects of crew rostering by linking rostering policy to multiple forms of flight crew safety behaviour, thereby moving beyond the predominant focus on fatigue and sleep. In doing so, our findings align with and extend prior work in aviation scholarship grounded in JD–R and COR (e.g., Chen & Chen, 2014; Li et al., 2013; Nahrgang et al., 2011). Specifically, we build on Chen and Chen (2014), who examined how job demands and job resources relate to cabin crew safety behaviours, by identifying the scheduling system itself as a concrete, organizational policy-level feature through which autonomy and inclusion are fostered (or constrained), with consequential implications for fatigue, dedication and flight crew safety behaviour. Furthermore, the links between autonomy and inclusion with fatigue and dedication are consistent with related research (e.g., Hämmig & Vetsch, 2021; Jung et al., 2024; Khushnood et al., 2020; Malinowska et al., 2018). Consistent with Khushnood et al. (2020) and Portoghese et al. (2014), our results underscore the importance of organizational policies that expand crew influence over work allocation, which appear to strengthen dedication and, in some cases, reduce fatigue, with implications for discretionary safety behaviours in particular (i.e., extra-role safety and upward safety communication).

Second, by integrating COR theory's ecological resource perspective with the JD–R model's dual-process logic, we respond to recent calls to sharpen COR applications by pairing its macro-level resource ecology with a more process-explicit account of employee functioning (Demerouti, 2025; Fletcher & Lysova, 2025), thereby clarifying the psychological mechanisms through which rostering policies affect safety outcomes. Consistent with calls to treat work arrangements as job design rather than mere administrative constraints (Demerouti, 2025; Fletcher & Lysova, 2025), we build on COR theory to conceptualize rostering policies as relatively enduring passageways that shape crews' resource ecology (Hobfoll et al., 2018). Building on JD–R's distinction between motivational and health-impairment processes (Bakker et al., 2023; Demerouti et al., 2001), we specify dedication and fatigue as complementary pathways linking these policy conditions to safety behaviour. Our findings suggest that dedication provided the more consistent explanation across outcomes, whereas fatigue played a more selective role by emerging for autonomy in relation to upward safety communication but not for inclusion. This pattern refines COR-based predictions by showing that passageways can shape safety behaviour even when health-impairment relief is not uniformly observed across resource types.

Third, we advance a resource-based view of scheduling by conceptualizing crew rostering policies as job-design features embedded in the scheduling system itself, rather than in task content only. This emphasis aligns with arguments that job design must account for the temporal architecture of work and recovery (i.e., when and how work is scheduled) because these arrangements structure exposure to demands and access to resources (Demerouti, 2025; Dettmers & Bredehöft, 2020). Consistent with COR theory, bidding policy regimes operate as organizational passageways that can protect (or erode) crews' resource reservoirs by shaping participation in work allocation and conditions for recovery (Hobfoll et al., 2018). Empirically, *advanced preferential bidding* was associated with greater perceived autonomy and inclusion (Study 1), and these perceptions mattered primarily for discretionary safety contributions and voice (that is, extra-role safety behaviours and upward safety communication) rather than for in-role safety. This evidence situates rostering-policy regimes as a concrete lever by which temporal work arrangements translate into resource-relevant perceptions with behavioural consequences.

Fourth, our findings reveal important theoretical distinctions between intrinsic and extrinsic passageway features. Specifically, the differential mediation patterns for autonomy and inclusion provide new insights into how these distinct features operate through different mechanisms. Autonomy, as an intrinsic job-design feature tied to individual schedule control (Dettmers & Bredehöft, 2020; Mehmood et al., 2026), influenced safety behaviours (extra-role and upward safety communication) through both reduced fatigue and increased dedication, whereas inclusion, as an extrinsic feature reflecting participation in broader organizational decision-making (Stiglbauer & Kovacs, 2018), was linked to upward safety communication and extra-role safety behaviours only through increased dedication. This suggests that, because it is embedded in day-to-day control over work allocation (Mehmood et al., 2026), autonomy may affect safety behaviour through both fatigue-related and motivational pathways, whereas inclusion may operate primarily through motivational mechanisms (Demerouti et al., 2001; Karasek, 1979). Also, this may also reflect the individualistic nature of aviation work, in which pilots and cabin crews operate in small, autonomous teams (Grant et al., 2024) and individual control may be more psychologically salient than organizational participation (Demerouti et al., 2019). Furthermore, the non-significant indirect effect of inclusion through reduced fatigue might also suggest boundary conditions for when participative passageway features translate into health-impairment outcomes. Whereas 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. 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).

Finally, the consistent absence of effects on in-role safety behaviours suggests that mandatory safety procedures may be relatively resilient to passageway-induced resource variation. According to the safety and compliance literature in commercial aviation (e.g., O'Neil & Krane, 2012; O'Neil & Kriz, 2013), such behaviours are tightly institutionalized within a broader high-reliability system, in which standardized training, recurrent checking and formal oversight help sustain procedural adherence and minimize tolerance for error. Here, in-role safety behaviours may be less sensitive to motivational and resource-based fluctuations than more discretionary forms of safety behaviour and may also be more prone to ceiling effects given aviation's intensive training and stringent regulatory requirements (Vaskova Kjulavkovska et al., 2022). Taken together, these findings suggest a boundary condition for resource-based explanations in safety-critical contexts: discretionary safety and safety voice appear more responsive to passageway-induced resources, whereas compliance-like outcomes may be shaped more strongly by professional norms, regulatory frameworks and intensive training (Mullen, 2004). All these possibilities could be addressed in future research.

PRACTICAL CONTRIBUTIONS AND SPECIFIC INDUSTRY IMPLICATIONS

Our study offers practical contributions. First, our findings provide specific guidance for airline managers designing and implementing roster planning and scheduling systems. 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. Moreover, for scheduling software developers, this implies prioritizing autonomy-enabling functionality such as flexible bidding algorithms, real-time schedule modifications and personalized preference matching. These design priorities align with evidence that greater crew participation in work allocation can help mitigate fatigue-related risks (Liu et al., 2023; Wang et al., 2023). Second, our study also informs organizational safety culture. Because extra-role safety behaviours and upward safety communication rely on discretionary initiative and speaking up (Chen & Chen, 2014), their effectiveness is likely strengthened in a supportive safety culture, particularly where management commitment and employee empowerment are salient, and where reporting systems encourage the open, non-punitive communication of safety concerns (Wiegmann et al., 2004). In parallel, airlines and regulators can reinforce these benefits by embedding roster planning within safety-management routines that create feedback loops and "reporting cultures" enabling learning from fatigue-related concerns and near-misses (Wiegmann et al., 2004). Finally, for regulatory bodies, our findings support regulatory frameworks that encourage (rather than mandate) crew preference systems within Fatigue Risk Management Systems (IATA, 2025). Consistent with a shared-responsibility view of fatigue risk management across regulatory, organizational and individual levels (Gander et al., 2011), airlines can treat scheduling policies as one controllable organizational lever within a broader fatigue risk management approach.

LIMITATIONS AND FUTURE RESEARCH

This study is not without limitations, which provide opportunities for future research. First, although the self-report measures for safety behaviours was appropriate for capturing behaviours that are inherently subjective and difficult to observe objectively, our findings could be subject to common method bias (Kock et al., 2021; Podsakoff & Podsakoff, 2019). While differential result patterns across safety behaviour types suggest that future research should maintain multidimensional safety assessments rather than use aggregate measures, future research could lean on other sources of data (e.g., direct supervisor ratings; Spector, 2019). Nonetheless, in our research to verify this possible effect, an assessment of common method variance was performed using Harman's single-factor test. The results indicated that a single factor accounted for 26.81% of the total variance, which is below the recommended threshold of 50% (Podsakoff & Organ, 1986). This outcome suggests that common method variance is unlikely to pose a significant threat to the validity of the study's findings.

Second, future research should explore additional mediating mechanisms beyond fatigue and dedication, perhaps including work-life balance, schedule predictability and social support resources (Badánik et al., 2021; Wen, 2024). Moreover, the examination of boundary conditions under which scheduling resources might influence mandatory safety procedures could provide valuable insights for extreme operational conditions under which resource preservation becomes critical for procedural adherence. For example, it should also test boundary conditions that are largely structural or operational, such as type of operation and duty sequencing (Lin et al., 2024), roster volatility (e.g., last-minute changes) (Wen, 2024), the tightness of seniority-based allocation constraints (IATA, 2025), and the strength of regulatory training and safety culture that may dampen variability in compliance-oriented behaviours (i.e., in-role safety) (ICAO, 2024; Mullen, 2004; O'Neil & Krane, 2012). These boundary conditions may also help explain the extent to which the model generalizes to other safety-critical domains (e.g., healthcare), where time and scheduling conditions can likewise shape compliance-related behaviour (e.g., Dai et al., 2015). More broadly, the underlying resource-based logic may extend beyond aviation, although the strength and pattern of these effects may vary because commercial aviation operates within a mature high-reliability system marked by highly standardized training, recurrent checking, formal oversight and stringent procedural requirements, which may reduce behavioural variability, especially for in-role safety outcomes (O'Neil & Krane, 2012; O'Neil & Kriz, 2013).

Third, cultural considerations warrant attention. Aviation's global nature means that 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 (e.g., Erez, 2010). Cross-cultural studies could examine whether our findings about intrinsic versus extrinsic resource effectiveness vary across cultural contexts. Finally, we conducted post hoc Monte Carlo simulations and a minimum detectable effect analysis (80% power, $\alpha = .05$), which suggested that our sample size ($N = 221$) was powered to detect small-to-moderate indirect effects (approximately .07 to .25) in Study 2's full SEM (Fritz & MacKinnon, 2007). However, very small indirect effects may have been difficult to detect and should be re-examined in larger samples (Fritz & MacKinnon, 2007).

Finally, although the extra-role safety behaviour measure was brief (two items) and Cronbach's alpha was slightly below the conventional .70 threshold (α = .67), omega indicated acceptable reliability (ω = .73). Following current psychometric guidance, omega may be the more informative estimate of reliability because alpha relies on more restrictive assumptions (Hayes & Coutts, 2020). Nonetheless, the brevity of the measure may have limited content coverage, and future research should therefore use more comprehensive multi-item measures.

CONCLUSION

This study is one of the first empirical examinations of how preference-stating opportunities in various 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. While 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 demonstrates 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.

AUTHOR CONTRIBUTIONS

Aníbal López: Conceptualization; methodology; software; investigation; validation; formal analysis; supervision; project administration; visualization; funding acquisition; writing – original draft; writing – review and editing; data curation. **João Bastos:** Conceptualization; methodology; software; resources; formal analysis; project administration; validation; visualization; investigation; funding acquisition; writing – original draft; writing – review and editing; data curation. **Catarina Correia Leal:** Conceptualization; methodology; validation; writing – original draft; writing – review and editing; supervision; investigation.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Appendix S1.

Appendix S2.

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