



The role of leadership in air traffic safety employees' safety behavior

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ABSTRACT

Safety behavior is the most critical task for air traffic controllers and other air traffic safety (ATS) employees. The literature shows that one of the main antecedents for ensuring safety is leadership. Yet, the understanding of leadership within air traffic control (ATC) is very limited. Drawing on both social learning theory and social exchange theory, the current research proposes and investigates the relationship between leadership aspects and ATS employees' safety behaviors.

Data were obtained from 49 ATS employees of a European air navigation service provider (ANSP), who rated their current supervisor's servant leadership, trustworthiness, leader-member exchange, and support for safety as well as their own safety compliance and safety citizenship behavior during one to five consecutive shifts. The results of hierarchical regression analyses showed, unexpectedly, a significant negative association between supervisors' trustworthiness and employees' safety citizenship behavior. None of the other hypothesized relationships was significant. These findings as well as additional findings from post-hoc interviews and open comment fields suggest that the specific ATC context may require different processes than other industries. Additionally, trustworthiness may be related to lower safety citizenship behavior, possibly because ATS employees believe trustworthy supervisors take care of everything. Although a closer additional examination is warranted, ANSPs might want to take into account difficulties associated with supervisors' trustworthiness.

1. Introduction

Employees' safety behavior, which is behavior benefitting colleagues', clients', the public's, and the environment's safety and health (Burke et al., 2002), consistently relates to safety outcomes, such as occupational injuries and accidents (e.g., Clarke, 2010, 2013). Safety behavior is a crucial factor for organizations as it not only links to physical harm, but safety outcomes also have negative organizational, social, and economic consequences (Burke et al., 2002; Zohar, 2002).

A large body of literature exists on antecedents of safety behaviors and outcomes, including several meta-analyses (e.g., Christian et al., 2009; Clarke, 2010; Nahrgang et al., 2011) and reviews (e.g., Beus et al., 2016; Donovan et al., 2016; Hofmann et al., 2017). These show that leadership is one of the main antecedents for ensuring safety. Different leadership aspects are important for safety behavior, such as constructive leadership styles (Christian et al., 2009; Donovan et al., 2016; Hofmann et al., 2017; Nahrgang et al., 2011), trust in the leader (Nahrgang et al., 2011), leader-member exchange (LMX; Christian et al., 2009; Donovan et al., 2016; Hofmann et al., 2017; Nahrgang et al.,

2011), and supervisor support for safety (Nahrgang et al., 2011). While leadership at different hierarchical levels seems to be important for safety, particularly the immediate supervisor plays a key role: "It is in the 'micro-decisions' made by these frontline managers and the degree to which day-in and day-out they reinforce and signal the importance of safety where the 'rubber meets the road' so to speak with respect to safety" (Hofmann et al., 2017).

Despite the evidence concerning the relations between leadership and employees' safety behavior, the role of leadership in air traffic control (ATC) has rarely been explored. ATC aims to "promote the safe, orderly, and expeditious flow of aircraft in flight or operating in the maneuvering area of an airport" (Ek and Arvidsson, 2012). In this context, "safety is the most important driver of operations" (Coetzee and Henning, 2019). Currently, flight movements in Europe are increasing, and expected to grow further with an average annual increase of 2.0% between 2019 and 2025 (EUROCONTROL, 2019). As such, maintenance of high safety levels is increasingly difficult and crucially depends on air traffic controllers (ATCOs)' behavior (Andersen and Bove, 2000).

It is important to examine whether the specific conditions of ATC

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require similar processes as other industries. As the context is important for particular outcomes, scholars have recommended to focus on the specific context when conducting research (Bamberger, 2008; Galvin, 2014; Tsui, 2006). Moreover, Mirza and Isha (2017) stated that “questions have been raised concerning leadership effectiveness mostly because extent literature remains largely oblivious to the context in which the leader-follower relationship operates”. For example, industries differ in types of job demands and risks inherent to the work, as well as concerning the person at risk being others or oneself. Consequently, the job demands and resources contributing the most to safety outcomes also differ between industries (Nahrgang et al., 2011).

The ATC context is especially unique from other settings when it comes to safety behavior and leadership. First, safety behavior in ATC is about operational safety, namely providing safe operational services and ensuring the safety of the surrounding. This differs from what is investigated in other safety research, namely occupational safety, which relates to the physical integrity of the workers themselves (Fruhen et al., 2013; Schwarz and Kallus, 2015). While in traditionally researched industries such as manufacturing, scholars typically discuss a trade-off between safety and operations (Veltri et al., 2013), in ATC, safety behavior is an important *part* of operations (Coetzee and Henning, 2019).¹ Besides orderliness and efficiency, safety is one of the three main performance outcomes in ATC (Griffin et al., 2000). In the literature, task performance is based on routine and adaptive performance (Pulakos et al., 2000). Hence, for ATC, safety behavior collapses largely with both routine and adaptive performance, which would make ATC a particular context in which safety is most crucial for performing well. As such, the predictions that hold for task performance seem relevant for safety behavior in this context. This is in contrast to safety research in which performance is more distant from safety behavior, where other predicting factors may be at play.

Second, supervisors in ATC have a different role than in other high-risk industries. Besides team organization tasks, such as ensuring adequate breaks, ATC supervisors also fulfil administrative tasks, such as reporting overtime hours and illnesses of employees, and technical tasks, such as coordinating runway changes. Furthermore, in some units the supervisor role is rotating, such that alternately supervisors are in a supervisor role in some shifts and in an employee role in others. As such, they may be the supervisor of an employee who is their own supervisor during another shift.

Due to this specific context, the current research aims to investigate the relationship between different leadership aspects - constructive leadership, trust, LMX, and supervisor support for safety - and employees' safety behavior in ATC. In a qualitative study, Read and Charles (2018) found that “the quality of supervision [...] can provide significant value or cause significant detriment to controllers”. The current research investigates whether “quality of supervision” also influences air traffic safety (ATS) employees' safety behavior. It follows a similar logic as the meta-analysis of Nahrgang et al. (2011) on safety outcomes, in that the current study also examines constructive leadership, trust, LMX, and supervisor support for safety, as these factors have been shown to be important for safety in other industries. The current research investigates the relationships between each of these leadership aspects separately and employees' safety behavior, as opposed to the approach of Nahrgang et al. (2011) of aggregating all leadership aspects into one overarching variable and investigating accidents and injuries, adverse events, and unsafe behavior as outcomes. Moreover, unlike the current study, which focusses specifically on ATC, Nahrgang et al. (2011) did not study the ATC context, but looked at the construction, health care, manufacturing/processing, and transportation industries.

The current study investigates the relationship between the above mentioned leadership aspects and ATS employees' safety behavior by means of a diary study design in a sample of ATS employees who rate

their current supervisor as well as their own safety behavior on a daily basis.

It draws on both social learning theory (Bandura, 1977, 1986) and social exchange theory (Blau, 1964; Gouldner, 1960) to clarify *why* constructive leadership aspects (in the form of a constructive leadership style, trustworthiness, LMX, and support for safety) relate to ATS employees' safety behavior.

Besides its value for the ATC industry, the current research also aims to contribute to the leadership and safety literature(s) by discussing a constructive leadership style that is relatively new to the safety literature, namely servant leadership. According to a recent meta-analysis (Hoch et al., 2018), this leadership style, in which employees, their needs, and the realization of their potential are of central importance (Liden et al., 2008), is more predictive of positive behavioral and attitudinal measures such as organizational citizenship behavior (OCB), employee engagement, job satisfaction, and organizational commitment than traditional leadership typologies.

In their review on the relationship between leadership styles and safety, Donovan et al. (2016) pointed out that our current knowledge about leadership's role in safety behavior and outcomes is “elementary at best”. From a practical point of view, we aim to show how to effectively maintain or increase ATS employees' safety behavior by focusing on supervisors' leadership. In the discussion, we also address how to support supervisors in their role of increasing and maintaining ATS employees' safety behavior.

2. Theory and hypotheses

2.1. Safety behavior

Safety behaviors may be divided into (1) *safety compliance*, referring to maintaining workplace safety by carrying out basic safety activities prescribed by the job, and (2) *safety participation*, referring to facilitating the development of a safety-supporting environment (Griffin and Neal, 2000). Examples of the former are behaving in accordance with safety rules and wearing protective equipment, whilst an example of the latter is participating in voluntary safety activities. This categorization reflects the more general distinction between task performance and contextual performance. Both task and contextual performance are distinct factors of ATS employees' performance, which contribute to ATS employees' perceived effectiveness (Griffin et al., 2000).

A further differentiation of safety behaviors is related to safety participation: *safety citizenship behavior*, the safety-specific variant of OCB (Hofmann et al., 2003). OCB can be defined as “performance that supports the social and psychological environment in which task performance takes place” (Organ, 1997). Safety citizenship behavior refers to behavior that facilitates a safety-supportive work environment. Hofmann et al. (2003) distinguish between six dimensions, namely safety-related helping, voice, stewardship, whistleblowing, civic virtue (keeping informed about safety issues), and initiation of change.

We follow the distinction between safety compliance and safety citizenship behavior. Moreover, the specificity of ATC that safety behavior concerns operational safety requires adapting safety behaviors that do *not* match the ATC context. We do this by replacing measures of these behaviors with measures of concrete operational safety behaviors. By focusing on concrete behaviors and measuring them on a daily basis, we satisfy the need for research on specific safety behaviors (Conchie, 2013; Curcuruto et al., 2015).

2.2. Leadership and safety behavior

Based on Nahrgang et al. (2011), we focus on (1) a constructive leadership style, which is operationalized as servant leadership, (2) trustworthiness of the supervisors, (3) LMX, and (4) supervisor support for safety.

According to social learning theory (Bandura, 1977, 1986), most

¹ We thank an anonymous reviewer for bringing up this issue.

behaviors are learned by role modeling (i.e., vicarious learning). This means that people observe others and may use the obtained information regarding successful behaviors to guide their own future behavior. Furthermore, social learning theory proposes that people with high status, power, and competence are more effective role models (Bandura, 1977). Thus, supervisors with favorable leadership characteristics are especially prone to serve as role models. As ATS supervisors' main task is to serve for safety, safety behavior is theorized to be the modeled behavior by ATS employees. The importance of role modeling in increasing employees' safety behavior has been highlighted by Murphy et al. (2012).

Social exchange theory's central paradigm is that the treatment of person A by person B is reciprocated by relational and/or behavioral responses of the same valence by person A (Gouldner, 1960). This is referred to as the norm of reciprocity. Favorable leaders treat employees well, which is expected to make employees reciprocating with positive behavior. This positive behavior can be hypothesized to be safety behavior in high-risk environments (Mirza and Isha, 2017), and more specifically in ATC, as reaching safety is the most important task of ATS supervisors.

Research in industries other than ATC shows that the impact of leadership on safety compliance is high, with average aggregated effect sizes of $r_c = 0.59$ ($\%R^2 = 22.2$) for manufacturing, 0.60 ($\%R^2 = 20.4$) for transportation, 0.62 ($\%R^2 = 50.1$) for construction and 0.69 ($\%R^2 = 32.5$) for health care. Similarly, leadership's impact on accidents and injuries (r_c between -0.16 and -0.40 and $\%R^2$ between 9.8 and 83.9) and adverse events (r_c between -0.20 and -0.41 and $\%R^2$ between 3.2 and 12.1) is significant (Nahrgang et al., 2011). Unfortunately, empirical data in the ATC context is missing. Even though ATS employees are trained to be very self-reliant and safety is fundamental to their attitude and job, leadership is expected to still be important for ATS employees' safety behavior. Read and Charles (2018) found that ATS employees perceive the supervisor role to be crucial to prevent unsafe events. Instead of actively guiding specific tasks, ATS supervisors are required to maintain employee support (e.g. given the high pressure ATS employees are subject to), while taking into account ATS employees' capability and personality as well as specific contextual circumstances.

2.2.1. Servant leadership

"Servant leadership stresses personal integrity and serving others, including employees, customers, and communities" (Liden et al., 2008). It entails having the skills to support employees, putting employees first, empowering them, and helping them to realize their potential. Moreover, servant leaders notice others' personal concerns, want to help the community, and behave ethically (Liden et al., 2008). While servant leadership was first introduced by Greenleaf (1977) in the 1970s, it has only recently received considerable research attention (Hoch et al., 2018; Liden et al., 2014a).

The leadership literature showed that servant leadership predicts variance above and beyond other leadership concepts for employee outcomes (Hoch et al., 2018; see also Liden et al., 2014a; Van Dierendonck, 2011) and hints on relations with the most important employee behaviors in ATC, namely, safety citizenship behavior and safety compliance. Findings that servant leadership relates positively to employee behaviors and outcomes have been replicated in the safety literature, albeit very preliminary and warranting further investigation (Mirza and Isha, 2017). For instance, two doctoral dissertations found a positive relation between servant leadership and safety behaviors and/or outcomes (Henderson, 2013; Krebs, 2005). More specifically, Krebs (2005) found servant leadership to be negatively related to near misses and accidents in a pharmaceutical organization, with a partial mediation by employees' actively caring for safety. Likewise, Henderson (2013) found servant leadership to be positively related to subordinates' safety voice in a sample of employees working in industrial and construction work contexts.

Second, unique characteristics of servant leaders, such as

empowering and helping employees to grow and succeed, are able to increase ATS employees' safety behavior. Indeed, ATS employees usually need to handle the traffic they are responsible for individually. That is, individual ATS employees have the complete picture of the traffic and supervisors are generally not required to help with task-related instructions (unless called upon). Instead, servant leaders help employees to stay focused on safety issues (e.g., by maintaining and discussing safety issues) and help them grow in their work, which allows ATS employees to perform better. Further, the overall most preferred leadership behavior by North-American ATCOs and ATC experts is coaching and supporting as supposed to directing and delegating (Melton et al., 2014). Servant leadership, as defined above, is the theoretical answer to ATS employees' personal preferences, which would therefore nurture positive outcomes as it aligns with ATS employees' prototypical leader (Epitropaki and Martin, 2005; Khorakian and Sharifirad, 2019). Moreover, while ATS employees are exposed to a high amount of work stress, potentially threatening their well-being (Tshabalala and De Beer, 2014), servant leadership actually has been argued to improve subordinates' wellbeing (Parris and Peachey, 2013). Finally, servant leaders are able to react to the changing needs of ATS employees in the dynamic ATC context, in which "situations can change rapidly, and controllers can be faced with very difficult problems in a short space of time" (Griffin et al., 2000).

Role modeling (Bandura, 1977, 1986) and social exchange (Blau, 1964; Gouldner, 1960) have been proposed as theoretical mechanisms for the association between servant leadership and positive work outcomes (Liden et al., 2014a). Servant leaders – more than other leaders – may act as role models because their pro-social behaviors and expertise make them interpersonally attractive and credible (Liden et al., 2014a, 2014b). In the literature, modeling is regarded a main attribute of servant leadership (Russell and Stone, 2002). According to Liden et al. (2014a), servant leaders' prosocial and moral identity is strongly modeled by employees. We consider this essential for safety citizenship behavior and safety compliance in high-risk environments, where enacting safety behavior is regarded as social and moral. Servant leaders appeal to employees' responsibility and accountability (Stouten and Liden, 2020), which would encourage employees' awareness to safety issues. Moreover, as employees become servant themselves, they show concern for people inside and outside the organization (Graham, 1991) and perform prosocial behavior and organizational and community citizenship behaviors (Liden et al., 2014a), which is expected to further enhance safety behavior.

Concerning social exchange, a servant leader treats employees well, leading employees to feel obliged to reciprocate with positive behavior (Gouldner, 1960; Liden et al., 2014a). This positive behavior can be hypothesized to be safety compliance and safety citizenship behavior in ATC, as servant leaders are concerned with employees' and the community's wellbeing (Liden et al., 2008), for which safety behavior in ATC is crucial. Additionally, employees' safety behavior is a performance indicator in high-risk environments, which may increase the likelihood of a good evaluation of the leader by senior management (cf., Hofmann and Morgeson, 1999). In line with this reasoning, Hofmann and Morgeson (1999) found that a social exchange mechanism increased employees' safety communication and safety commitment. Therefore, we formulate:

Hypothesis 1a. Servant leadership is positively related to ATS employees' safety compliance.

Hypothesis 1b. Servant leadership is positively related to ATS employees' safety citizenship behavior.

2.2.2. Trustworthiness

Perceived trustworthiness describes a person's attributional judgement of another person (i.e., trustee), based on the trustees' ability, benevolence, and integrity (Jones and Shah, 2016; Mayer et al., 1995). It is a key determinant of trust for a trustee (Jones and Shah, 2016; Mayer

et al., 1995) and trustworthiness and trust are highly correlated (Colquitt et al., 2007; Mayer and Gavin, 2005). The supervisor has been shown “to be a particularly important referent of trust” (Dirks and Ferrin, 2002), and meta-analytic research shows positive relationships of trust in the leader with both task performance and organizational citizenship behavior (Colquitt et al., 2007; Dirks and Ferrin, 2002).

Trust is important for safety. For example, Conchie and Donald (2009) found that safety-specific trust moderated the relationship between safety-specific transformational leadership and safety citizenship behaviors, such that the relationship was only significant when trust was moderate or high. Moreover, Conchie et al. (2012) found trust to mediate the relationship between safety-specific transformational leadership and safety citizenship behaviors. Finally, Conchie (2013) found that trust in the leader moderated the mediated relationship of safety-specific transformational leadership with whistle-blowing and safety voice via intrinsic motivation. In all of these three studies, trust was positively related to safety citizenship behaviors. Finally, Lofquist (2011) found that a loss of trust in leadership led to ATCOs’ resistance to change. Yet, initiating safety-related change is one dimension of safety citizenship behavior (Hofmann et al., 2003). To our knowledge, the relationship between trust(worthiness) and safety compliance has not directly been investigated. However, the positive relationship between trust in the leader and task performance has been confirmed convincingly (Colquitt et al., 2007; Dirks and Ferrin, 2002), whereby safety compliance resembles task performance in ATC.

Trust is also related to safety-related incidents (Baas, 2002) and patient safety (Verschuere et al., 2013), and it has the potential to enhance the present safety culture (Dejoy, 2005; Jeffcott et al., 2006), a major antecedent of safety behaviors (Beus et al., 2016). Within ATC, an important safety culture aspect is a *just culture*, reflecting “an atmosphere of trust where people are encouraged and even rewarded to provide essential safety-related information, but also in which it is clear where the line between acceptable and unacceptable behavior is drawn” (Fruhen et al., 2013). Just culture is thus very similar to the concept of *psychological safety*. Trust in the supervisor is an important element of a just culture, which encourages reporting errors, mistakes, or near-misses, important safety behaviors in ATC (Fruhen et al., 2013).

Social exchange (Blau, 1964; Gouldner, 1960) has been proposed to explain the positive relationship between leaders’ trustworthiness and employees’ task performance and citizenship behavior (Colquitt et al., 2007). According to social exchange theory, trust is necessary for social exchange to occur (Blau, 1964). Additionally, “many of the facets of trustworthiness can be viewed as currencies that help create a social exchange. For example, trustworthiness facets such as demonstrating concern and support or acting based on sound principles can be viewed as actions that should engender a motivation to reciprocate on the part of an exchange partner” (Colquitt et al., 2007). Indeed, trust would also instill the motivation to follow through on explicit and implicit rules (Stouten and Liden, 2020). Following the norm of reciprocity (Gouldner, 1960), ATS employees are expected to react with safety compliance and safety citizenship behaviors to the favorable treatment by their supervisors, in this case reflected by their trustworthiness. Taken together, we propose:

Hypothesis 2a. Trustworthiness is positively related to ATS employees’ safety compliance.

Hypothesis 2b. Trustworthiness is positively related to ATS employees’ safety citizenship behavior.

2.2.3. Leader-member exchange

Leader-member exchange (LMX) reflects the degree to which a supervisor-employee dyad relationship is characterized by mutual respect, trust, and obligation, and therefore can be defined as a high-quality exchange relationship (Colquitt et al., 2014). Meta-analytic research confirms a positive relationship between LMX and job performance (Gerstner and Day, 1997) as well as OCB (Ilies et al., 2007).

In the safety literature, LMX has repeatedly been shown to relate positively to safety behavior, safety commitment, safety climate, and safety outcomes such as safety-related events and accidents (Donovan et al., 2016). Specifically concerning safety behavior, Hofmann et al. (2003) found that LMX was related to employee safety citizenship behavior. Moreover, several authors found LMX to relate positively to employee safety communication (Hofmann and Morgeson, 1999; Kath et al., 2010; Michael et al., 2006). Finally, (Yang et al., 2020) found LMX to be positively correlated with safety behavior, measuring it as combination of safety compliance and safety citizenship behavior.

In the ATC context, scholars also argued that LMX is important for safety. Coetzee and Henning (2019), referring to the ATC context, formulate it as follows: “An operational environment where all employees take responsibility and continuously consider the impact of their decisions on safety relies on a high degree of mutual trust, respect and effective communication between employees and their leaders”. They further argue that more than in other contexts, LMX is especially applicable in ATC “where high levels of authority, trust, cooperative interactions and information sharing are important” (Coetzee and Henning, 2019). Additionally, Jiang et al. (2017) found a positive relationship between LMX and employees’ safety citizenship behavior in a sample of ATCOs and airline maintenance employees.

LMX has been linked to outcomes based on social exchange theory (Ilies et al., 2007; Settoon et al., 1996). Indeed, social exchange theory explicitly deals with “mutually contingent exchange” (Blau, 1964), relating very closely to LMX as relationship characterized by mutual exchange (Colquitt et al., 2014). Drawing on social exchange theory, employees are expected to feel obligated to reciprocate supervisors because of high-quality LMX. In an ATS context, this is expected to be expressed as employees’ safety compliance and safety citizenship behavior, as argued for above. Accordingly, we hypothesize:

Hypothesis 3a. LMX is positively related to ATS employees’ safety compliance.

Hypothesis 3b. LMX is positively related to ATS employees’ safety citizenship behavior.

2.2.4. Supervisor support for safety

In the safety literature, an ongoing debate exists about whether to use general or safety-specific leadership when investigating safety-related outcomes (Conchie, 2013; Mullen and Kelloway, 2009). On the one hand, preliminary evidence suggests that safety-specific leadership has an incremental association with safety outcomes beyond general leadership (Mullen and Kelloway, 2009). On the other hand, scholars also argue that safety-specific leadership ignores leaders’ non-safety-related tasks and its application might lead to a confounding of leadership and safety climate or employee safety behavior (Inness et al., 2010). Given that both perspectives seem relevant, the current research incorporates both general leadership and safety-related leadership. Hence, we also examine perceived supervisor support for safety, which is defined as “the extent to which people believe their supervisor values safety as reflected in communication, encouragement, and consequences” (Christian et al., 2009).

Meta-analytic research shows that supervisor support for safety is significantly related to employees’ safety behavior and safety outcomes such as accidents and injuries (Christian et al., 2009). For example, Hayes et al. (1998) and Thompson et al. (1998) found supervisors’ safety support to be positively related to employees’ safety compliance. Moreover, Simard and Marchand (1994) found supervisors’ involvement in safety activities to be related to workers’ safety compliance and safety initiative.

Additionally, a positive association between safety-specific transformational leadership and safety citizenship and compliance behavior has been shown (e.g., Conchie, 2013; Conchie and Donald, 2009; Mullen and Kelloway, 2009), such that Mirza and Isha (2017) even refer to it as “lead predictor of occupational safety”. Safety-specific transformational

leadership refers to “behaviour that is characteristic of the components of transformational leadership, yet specifically focused on inspiring and promoting positive safety-related practices” (Mullen and Kelloway, 2009). Thus, this leadership style finds similarities with supervisor support for safety.

Moreover, managers’ openness, norms, and reactions concerning safety reporting (reflecting safety support) play a relevant role in employees’ incident reporting and raising of safety issues (Clarke, 1998; Mullen, 2005). As perceptions of management support for safety and supervisor support for safety are related (Thompson et al., 1998), we contend that this also translates into a positive association between supervisors’ safety support and employees’ safety behavior. Indeed, Probst and Estrada (2010) found that supervisors’ safety enforcement was related to less underreporting of accidents and fewer occurred accidents. As discussed above, incident reporting is an especially important aspect in ATC and is part of the just culture concept in the industry (Fruhen et al., 2013). Additionally, supervisor commitment to safety as perceived by ATS employees, a concept akin to supervisor safety support, has been found to be an important indicator of an ATS employees’ perceived safety culture (Stroeve et al., 2011), which, in turn, is related to ATS employees’ safety behavior (Schwarz and Kallus, 2015).

Theoretically speaking, Tucker et al. (2008) argue that support for safety triggers a safety-related social exchange process: “when supervisors and managers convey concern for employee safety by valuing suggestions for improving safety, workers develop beliefs that their organization has a positive orientation toward safety, which in turn increases the probability that workers will instigate or participate in safety-related exchanges [...] and participation in other safety-related activities”. Thus, following the principles of social exchange theory (Blau, 1964; Gouldner, 1960), ATS employees are expected to reciprocate their supervisors’ safety-supportive behavior by enacting safety compliance and safety citizenship behavior.

Moreover, a role modeling mechanism may account for the expected relationships. Following the definition given above, supervisor support for safety is reflected in supervisors’ behavior expressing that they value safety. This would translate into supervisors’ safety behavior, especially in the ATS context, where supervisors engage in front-line tasks as well. Following social learning theory (Bandura, 1977, 1986), leaders’ behaviors are often modeled. Hence, safety-supportive behaviors of supervisors are expected to be modeled by ATS employees, which would encourage ATS employees’ safety compliance and safety citizenship behavior. Taken together, we formulate:

Hypothesis 4a. Perceived supervisor support for safety is positively related to ATS employees’ safety compliance.

Hypothesis 4b. Perceived supervisor support for safety is positively related to ATS employees’ safety citizenship behavior.

The conceptual research model is depicted in Fig. 1.

3. Method

3.1. Study environment

We conducted the study with operational air traffic safety (ATS) employees from a European air navigation service provider (ANSP). The ANSP entails different units. The two air traffic control (ATC) center units “ATC center 1” (42.2% of all ATS employees) and “ATC center 2” (11.8% of all ATS employees) and the largest tower unit “tower 1” (16.7% of all ATS employees) have between 12 and 21 supervisors each. There is/are nearly always one supervisor (in ATC center 2 and tower 1) or two supervisors (in ATC center 1) present in the operational room, and they are mainly tasked with operational supervisory roles (e.g., taking decisions concerning runway usage). By contrast, the five regional towers (in total 29.3% of all ATS employees) have one or two supervisors in total, who primarily have a coordinating/organizing role

(e.g., administrative support, coordinating activities with the airport), and who are not present all the time.

Most supervisors also act as ATS employees, depending on the shift. This implies that during some shifts they are in the supervisor role, whereas in other shifts they are in the ATS employee role. This is the case in the regional towers and in ATC center 2 (for all supervisors), in ATC center 1 (for all supervisors but one) and in tower 1 (for only two supervisors). It shows the complexity of the organization, in which multiple locations and supervisor roles are dispersed. Finally, in none of the units there is a fixed team structure, such that team compositions change every shift.

3.2. Study design

We applied a diary study design in order to test our research model. By conducting a diary study in the described context, we aimed to investigate leadership associations via differences in leadership behavior and safety variables within-employees and thereby to rule out differences between employees affecting the results. Studying leadership on a daily basis is a recent trend, which has important benefits and has shown that leadership fluctuates daily; hence, a diary-study approach is encouraged (Kelemen et al., 2019). To obtain enough data while not overwhelming our participants, we chose for five measurements. These referred to five consecutive shifts for each employee, and had to be completed towards the end of or after each shift.

3.3. Participants

The 287 ATS employees working at the ANSP formed the pool of potential participants that were invited to participate, and included a) 230 air traffic controllers (ATCOs), b) 23 employees of the flight data services (FDS), partly also working as operational employees of the flight information center (FIC), also called flight information service officers (FISOs), c) 27 on-the-job trainees (OJTs), and d) 6 aerodrome flight information service officers (AFISOs).

Initially, 82 employees participated in the study, reflecting 28.6% of the sample. Of these, eleven only opened the introductory page of the survey, one stopped at the informed consent, and nineteen did not continue after demographic/shift questions. Furthermore, two participants did not reply correctly to any of our two attention checks (“Please select option ‘Strongly disagree’”). We excluded all these participants from our analysis, yielding a useable sample of 49 employees and an effective response rate of 17.1%.

Further, a high dropout rate throughout the diary study was observed. We checked whether participants completed all five diary surveys at the same day and if this was the case, we excluded those participants’ day 2 to 5 survey data from the analyses. This concerned four participants. Considering those, 10 participants stopped during day 1, while 39 finished at least day 1. Of these 39, only 18 started day 2, of which also 13 finished it. Of these 13, eight started, of which seven finished day 3. Of these, five started and finished day 4, of which all started and four finished day 5.

Of the 49 useable initial participants, 38 were male (77.6%) and 10 female (20.4%; one participant (2.0%) indicated “Other / do not want to answer”). On average, participants were 40.61 years old ($SD = 8.53$) and worked for 16.37 years for the ANSP ($SD = 8.22$). Most of the participants indicated secondary education as their highest obtained degree (46.9%), while 28.6% indicated a bachelor’s and 20.4% indicated a master’s degree. Two participants indicated an “other” degree (4.1%). While 44.9% worked in ATC center 1 and 10.2% in ATC center 2, 18.4% worked in tower 1 and 26.5% in one of the regional units. Most participants worked mainly as area controller (38.8%), approach controller (20.4%), or tower controller (20.4%), while some mainly worked as

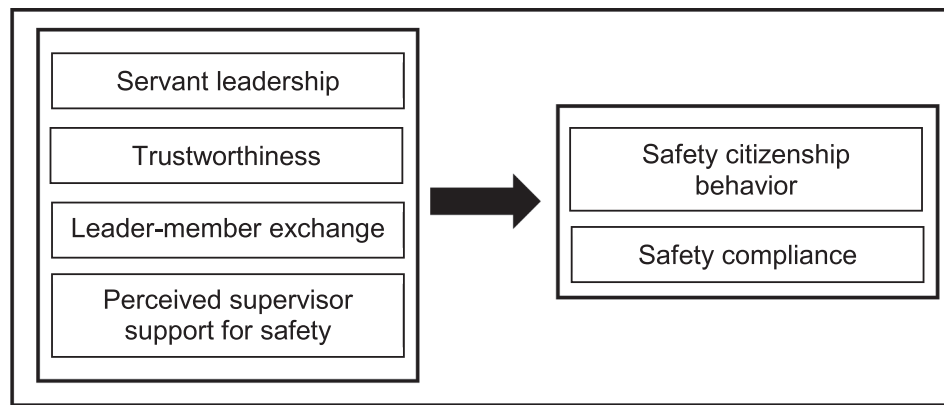


Fig. 1. Conceptual research model.

FDS, FIC/FISO (each 6.1%), OJT, or AFISO (each 4.1%).²

3.4. Procedure

Before the actual data collection, the first author visited the different units to familiarize with the context and inform ATS employees and supervisors about the research. She also informed employees from the safety, human resources, and human factors department, as well as senior managers about the research. From several of these employees, she collected input on the research topics and questionnaire in order to ensure that participants were fully informed, the survey structure was optimized, and the content was motivating for participants and relevant to the context, while still including valid measures from the literature.

One week before the data collection, all ATS employees were informed about the research, its purpose, and the coming data collection via email. At the start of the data collection, they received a link to an online survey, and the explanation that it would need to be completed towards the end of or after each of the next five consecutive shifts. The online survey consisted of one longer version and subsequently four times a shorter version (for each of the consecutive days). At the end of each questionnaire page, an open comment field allowed the respondents to add any additional information or comments. All communication and questions were in English, the corporate language. During the data collection, the first author visited the units to inform participants about the study, ask input, and answer questions. After the data collection and analyses, the first author conducted interviews to contextualize the findings and support their interpretation.

3.5. Measures

All items were rated on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*), except for the control variables and measures of safety citizenship behavior and safety compliance, which were indexed from 1 (*never*) to 5 (*very frequently*). All measures were assessed daily, except the control variables, which were only assessed at the first measurement. We instructed employees to refer to their behavior, motivations, and evaluations during their last shift and concerning their last shift's supervisor. We relied on validated scales, adapted to the diary study design and the ATC context where necessary.

3.5.1. Servant leadership

To measure servant leadership of the supervisor, we used the seven-item short form of the servant leadership measure (Liden et al., 2008). To tailor it to our context, we replaced the word "manager" by "supervisor". An example item is: "I would seek help from my supervisor if I

had a personal problem". Cronbach's alpha for that scale is 0.84.³

3.5.2. Trustworthiness

To measure trustworthiness on a daily basis, we used the three-item measure of trustworthiness developed by Jones and Shah (2016). Instead of using names, we referred to *supervisor*. Additionally, we transformed the questions into statements and asked for the extent of agreement. For example, we changed the item "To what extent does [first name] have the ability to complete high quality work—does [he/she] have the knowledge and skills needed?" to "Your supervisor has the ability to complete high quality work—he/she has the knowledge and skills needed". The scale's Cronbach alpha is 0.95.

3.5.3. Leader-member exchange

We measured LMX with the social exchange relationship scale (SERS) of Colquitt et al. (2014). The SERS measures social exchange by asking whether the relationship with one's supervisor is characterized by mutual obligation, trust, commitment, and significance. Following Mawritz et al. (2017), we asked employees to rate their (dis)agreement with the four characterizations of their relationship with their supervisor. The scale's alpha reliability is 0.78.

3.5.4. Perceived supervisor support for safety

We used a three-item measure developed by Tucker et al. (2008) measuring perceived coworker support for safety, and changed the words "coworkers" and "colleagues" to "supervisor" to measure perceived supervisor support for safety. An example item is: "My supervisor encourages others to work safely". Cronbach's alpha for that scale is 0.80.

3.5.5. Safety compliance

Safety compliance is often measured with a four-item scale developed by Neal et al. (2000). However, the items do not apply to the ATC context. For example, as safety is so critical in ATC, all ATS employees would most probably strongly agree with the item "I carry out my work in a safe manner". Therefore, we did not use the scale of Neal et al. (2000), but used four items from the ATCO competency framework instead. This framework includes ten crucial competencies for ATS employees, more specific competence elements, and observable behaviors reflecting these competence elements. It has been thoroughly developed by the ANSP in collaboration with the International Civil Aviation Organisation in compliance with EU regulation 2015/340 (European Commission, 2015). The items we used reflect five overt behaviors referring to four different competences, which fit the definition of safety compliance as maintaining workplace safety by carrying

² Unit and position were taken from day 1 of the diary study.

³ The Cronbach's alphas were estimated based on the original data of day 1.

out basic safety activities prescribed by the job (Griffin and Neal, 2000) the best. An example item is “Applying appropriate air traffic separation and spacing”. All items measuring safety compliance can be found in Table 1. Cronbach’s alpha for that scale is 0.80.

3.5.6. Safety citizenship behavior

To assess safety citizenship behaviors, we used items of a scale developed by Hofmann et al. (2003). In discussion with ATS experts, we chose the most relevant behaviors for the ATC context. Additionally, one slightly adapted item from the ATCO competency framework was added to replace two items of the *civic virtue* dimension of Hofmann et al. (2003), as their reference to “safety meetings” does not make sense in ATC. The *whistleblowing* and *stewardship* dimensions were not included, as these behaviors rarely or never occur in ATC. All items measuring safety citizenship behavior can be found in Table 1. The scale’s Cronbach alpha is 0.87.

3.5.7. Control variables

We accounted for several alternative explanations and possibly confounding variables that emerge in the literature by including different control variables. First, we controlled for demographics, namely age, gender, and highest degree obtained, as they relate to safety behavior (e.g., Kark et al., 2015; Pek et al., 2017). Second, we controlled for work experience at the ANSP, as it has been found to be negatively

related to trust in supervisors in an ATC sample (Cho and Park, 2011), and at the same time “experience is a critical factor in aviation safety” (Coetzee and Henning, 2019). Lastly, we controlled for the unit, the main position during the last work shift (area controller, approach controller, tower controller, or “other” (FDS, FIC/FISO, OJT, or AFISO)), and the kind of this shift (week or weekend/holiday, and early, day, late or night). We tested for associations between the control variables and our study variables to assess whether they should be controlled for while testing our hypotheses.

3.6. Analysis strategy

Due to the low sample size, rather than to aggregate to the supervisor level, we treated all variables at the individual level. Furthermore, the initially planned crossed random effects models (as days are nested within respondents due to the diary study design and days are nested within supervisors) were also unfortunately not permitted with our small sample size. Therefore, we restricted ourselves to descriptives, correlations, and multiple regression analyses. While the descriptives present participants’ means, standard deviations, and proportions of their responses on the different days, the correlations and regression analyses were based on the responses on day 1 only, as the number of participants on days two to five did not allow for multilevel analyses. We performed hierarchical regression analyses adding control variables in step 1 and predictors in step 2 to investigate whether the leadership aspects were associated with ATS employees’ safety compliance and safety citizenship behavior beyond the associations between the control variables and outcomes.

For the categorical variables with more than two categories (i.e., unit, position, and day shift), we formed dummy variables, representing (1) the units tower 1, regional unit, or ATC center 2 (with ATC center 1 as reference), (2) the positions area controller, approach controller, or tower controller (aggregating all other positions as “other” category and reference), and (3) intermediate, late, or night shift (with early shift as reference).

We checked whether the occurrence of missing data was related to other data that was measured in the dataset, by computing t-tests investigating whether participants who finished at least the day 1 survey and participants who did not finish it differed in terms of their demographics, work experience at the ANSP, dependent, or independent variables. We found a significant difference between those two groups, that is, participants who stopped during the day 1 survey had a higher trustworthiness towards their supervisor ($t(42) = 2.11$, $p = .03$). Consequently, the data is not missing completely at random, meaning that “the probability that a variable value is missing does not depend on the observed data values nor on the missing data values” (Newman, 2014). To approach item- and construct-level missing data at day 1, we applied a multiple imputation analysis, as has been recommended in the literature (Enders, 2010; Newman, 2014). The advantage of this analysis is that bias and error due to missing data is reduced (Newman, 2014). We applied 50 imputations (Enders, 2010) and applied an item-level (as opposed to construct-level) imputation to incomplete items (Gottschall et al., 2012). We added all items measuring independent, dependent, or control variables, and a variable indicating at which point in the survey participants dropped out as auxiliary variable, to take into account that most missing values occurred due to drop out. The reported results are for the pooled multiple imputation set, unless otherwise specified.

Additionally, multicollinearity was checked by investigating the predictors’ variance inflation factors (VIFs). Moreover, we performed a post-hoc power-analysis with G*Power 3.1 (Faul et al., 2009) to assess the observed power of the linear multiple regression (fixed model, R^2 increase after entering the control variables). We excluded one participant’s responses on the diary variables of day 1, because (s)he gave as a comment “I did not work today”.

Table 1
Safety compliance and safety citizenship behavior items.

Construct	Source	Dimension	Item
Safety compliance	ATCO competency framework		Managing arriving, departing and/or en route traffic using prescribed procedures
			Applying appropriate air traffic separation and spacing
			Verifying accuracy of readbacks and correct as necessary
			Following prescribed procedures for communication and coordination of urgent situations.
Safety citizenship behavior	Hofmann et al., 2003	Helping	Coordinating the movement, control and transfer of control for flights using the prescribed coordination procedures
			Assisting others to make sure they perform their work safely
		Voice	Helping others with safety-related responsibilities
			Making safety-related recommendations about work activities
			Expressing opinions on safety matters even if others disagree
		Initiating safety-related change	Trying to change the way the job is done to make it safer
			Trying to change policies and procedures to make them safer
		Civic virtue (Keeping informed)	Keeping informed of changes in safety policies and procedures
			Maintaining, through personal initiative, good knowledge of aviation safety evolution
	ATCO competency framework		

Note. The stem for these items was: “How often have you engaged in the following behaviors today?”.

4. Results

Table 2 presents the correlations of the study variables of the day 1 survey and Table 3 presents the sample sizes, manifestation frequencies, means, and standard deviations of all survey days.

As can be seen from Table 2, servant leadership, trustworthiness, LMX, and supervisor support for safety were all strongly correlated (r between 0.42 and 0.84, p in each case < 0.01). Moreover, the safety behaviors (i.e., safety compliance and safety citizenship behavior) were strongly correlated ($r = 0.49$, $p < .01$). Finally, two control variables were correlated with one of the outcome variables. Work experience at the ANSP was strongly correlated with safety compliance ($r = 0.41$, $p < .01$), such that more experience was associated with more safety compliance behavior. Week vs. weekend shift was related to safety citizenship behavior ($r = -0.29$, $p = .04$), such that weekend shifts were related to lower safety citizenship behavior.

4.1. Main analyses

As proposed in the literature, we restricted the control variables in our main analyses to those that showed significant relations with the dependent variables (i.e., safety compliance and/or safety citizenship behavior; Becker, 2005). Table 4 presents the results of the hierarchical regression analyses, including the unstandardized regression coefficients of the predictors on the two dependent variables, while controlling for work experience at the ANSP and week vs. weekend shift.

Concerning the control variables in step 1, work experience at the ANSP was significantly related to safety compliance ($b = 0.03$, $p = .01$), but not to safety citizenship behavior ($b = 0.01$, $p = .32$). Week vs. weekend shift was neither significantly related to safety compliance ($b = -0.25$, $p = .18$), nor to safety citizenship behavior ($b = -0.46$, $p = .08$). Thus, we only found support for a (positive) relationship between work experience at the ANSP and safety compliance.

The results showed *no* significant associations between servant leadership on the one hand and safety compliance ($b = 0.17$, $p = .24$) and safety citizenship behavior ($b = 0.39$, $p = .07$) on the other, after controlling for work experience at the ANSP and week vs. weekend shift. Thus, *no* support was found for Hypotheses 1a and 1b.

Trustworthiness was *not* significantly related to safety compliance ($b = -0.08$, $p = .56$), but did reveal a significant, unexpected *negative*, relation with safety citizenship behavior ($b = -0.37$, $p = .05$), after controlling for work experience at the ANSP and week vs. weekend shift. Hence, *no* support was found for Hypotheses 2a and 2b.

The results showed *no* significant associations between LMX on the one hand and safety compliance ($b = -0.03$, $p = .82$) and safety citizenship behavior ($b = 0.06$, $p = .78$) on the other, after controlling for work experience at the ANSP and week vs. weekend shift. Thus, *no* support was found for Hypotheses 3a and 3b.

Finally, perceived supervisor support for safety was neither related to safety compliance ($b = -0.03$, $p = .81$) nor to safety citizenship behavior ($b = 0.11$, $p = .49$), after controlling for work experience at the ANSP and week vs. weekend shift. Therefore, there was *no* support found for Hypotheses 4a and 4b.

4.2. Additional quantitative analyses

The highly significant correlations between the leadership concepts might indicate a problem with multicollinearity. However, additional analyses indicated the *VIF* for the different leadership variables to be between 1.36 and 3.58⁴ and thus below the commonly used cut-off points of 5 or 10 (McEvoy, 2018).

The post-hoc power-analysis revealed a power of 0.20 for safety compliance (effect size $f^2 = 0.05$) and 0.58 for safety citizenship

behavior (effect size $f^2 = 0.17$). Thus, the chance of finding significant results in case they actually existed is estimated at only 20% for safety compliance and 58% for safety citizenship behavior, rendering a high probability of not finding significant relationships even if those would, in fact, be present in the larger population.

4.3. Post-hoc interviews and open comment fields

To further contextualise and interpret the findings as well as derive insights about possible explanations and implications, the first author interviewed people holding various positions at the ANSP where the current research was conducted. In addition, the contents of open fields of the questionnaire were considered. Eleven interviews were conducted, of which eight one-on-one and three group interviews; Table 5 shows an overview of all invitees and participants. Of the non-operational employees, many had worked as ATS employees and/or supervisors in the past (i.e., part of the director's committee, the human factors specialists, part of the safety unit, the senior manager). During the interviews, the first author presented the results and asked for possible interpretations, contextualization, and suggestions for implications.

4.3.1. Supervisors' leadership role and behavior

The interviews delivered important insights pertaining to the leadership role and behavior of supervisors. Supervisors' leadership behavior may be limited due to various reasons that relate to supervisors' role definition. For example, during some interviews, supervisors' feedback-giving was discussed, which in the general and safety literature is regarded as essential leadership behavior that increases employees' general task performance (Larson, 1984) and safety behavior (Zohar and Luria, 2003). Feedback-giving of supervisors was indicated to be present only to a very limited extent in the ANSP. This was partly attributed to the rotating leadership system during the interviews, which can also be illustrated by an ATS employee's note in an open comment field throughout the survey: "we don't receive feedback from supervisor. They are one day supervisor and another day our direct colleague. So as far as possible they won't criticize or give any feedback". Thus, supervisors may perceive it as difficult to take up a leadership role in a rotating leadership system and consequently may be reluctant to do so. Additionally, the fact that supervisors are (former) ATS employees was mentioned to possibly play a role in supervisors' reluctance to take up a leadership role. Following that reasoning, the transition from colleague to leader would be difficult, especially in combination with a rotating leadership system where the transition of roles is not permanent.

Moreover, interviewees indicated that many supervisors may not perceive giving feedback as part of their role. Also, more generally, ATS supervisors' role definition seems to lack leadership aspects. For example, ATS supervisors' job descriptions and trainings mainly include coordinating and operational but scarcely leadership aspects. Relatedly, supervisors are often not seen as "leaders". For example, in an open comment field at the end of the survey, an ATS employee asked: "can we do the same survey concerning middle and high management? not a supervisor who is practically a member of the team?" (sic). This illustrates that supervisors seem to be regarded as team-members rather than team-leaders.

Summarizing, supervisors' role definition seems to lack leadership aspects, which may make them reluctant to engage in leadership. Yet, in combination with their appointment as supervisors, they may lack role clarity. The lack of clarity about ATS supervisors' leadership role may possibly account for the non-significant relationships between leadership aspects and safety behavior.

4.3.2. The role of other job functions

Another aspect that could lead to a reduced leadership role and role clarity of the supervisors in the ANSP is that besides the supervisors, operations-coordinators (ops-coordinators) and senior potentials exist. Ops-coordinators are air traffic controllers and/or supervisors who also

⁴ Based on the original data.

Table 2
Correlations of study variables on day 1.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Age																			
2. Gender ^a	0.08																		
3. Degree	0.02	0.05																	
4. ANSP work experience	0.66**	0.13	−0.07																
5. Regional unit ^b	−0.08	0.07	−0.21	−0.15															
6. Tower 1 ^b	−0.30*	−0.25	−0.02	−0.20	−0.29*														
7. ATC center 2 ^b	0.22	−0.01	−0.05	0.32*	−0.20	−0.16													
8. Intermediate shift ^c	−0.21	0.11	−0.19	−0.29	0.48**	−0.18	−0.13												
9. Late shift ^c	−0.02	−0.25	0.02	0.04	−0.22	−0.11	0.05	−0.26											
10. Night shift ^c	−0.14	0.05	−0.02	0.08	0.03	0.05	0.09	−0.24	−0.44										
11. Week vs weekend shift ^d	−0.14	−0.02	0.02	−0.26	0.30*	−0.15	0.12	0.37**	−0.09	0.17									
12. Tower controller ^e	−0.47**	−0.09	−0.15	−0.35	0.27	0.41	−0.17	0.12	−0.03	0.13	0.18								
13. Approach controller ^e	0.24	0.11	−0.08	0.34*	0.38**	−0.24	0.50	0.12	−0.14	0.13	0.18	−0.26*							
14. Area controller ^e	0.26	0.10	−0.05	0.42**	−0.48	−0.16	−0.13	−0.30*	0.16	0.05	−0.36*	−0.40	−0.40						
15. Servant leadership	−0.05	−0.10	0.24	0.10	−0.35*	0.11	0.26	−0.27	−0.04	0.10	0.12	−0.01	−0.12	0.16					
16. Trustworthiness	0.11	−0.16	0.27	0.18	−0.47	0.06	0.20	−0.30*	0.03	0.02	0.07	−0.22	−0.13	0.27	0.84**				
17. LMX	0.07	−0.09	0.40	0.19	−0.37*	0.07	0.14	−0.38	0.19	−0.03	−0.17	−0.29	−0.03	0.17	0.57**	0.52**			
18. Supervisor support for safety	0.28	0.01	0.29	0.36*	−0.15	−0.03	0.18	−0.23	−0.07	0.02	−0.17	−0.27	0.23	0.07	0.44**	0.42**	0.51**		
19. Safety compliance	0.19	0.16	−0.04	0.41**	−0.14	0.11	0.11	−0.23	0.12	0.04	−0.28	0.00	−0.09	0.23	0.17	0.13	0.15	0.19	
20. Safety citizenship behavior	0.04	0.15	−0.10	0.21	0.02	−0.06	0.11	−0.14	−0.07	0.05	−0.29*	−0.03	−0.03	0.06	0.14	−0.02	0.20	0.25	0.49**

N = 49 (pooled imputed data of day 1).

^a Gender is coded as 0 for males and 1 for females.

^b The unit variables are dummy-coded, such that 1 refers to employees working in the respective unit and 0 to employees working in another unit.

^c The shift variables are dummy-coded, such that 1 refers to employees working in the respective shift and 0 to employees working in another shift.

^d Week vs. weekend shift is coded as 0 during the week and as 1 during the weekend.

^e The position variables are dummy-coded, such that 1 refers to employees working in the respective position and 0 to employees working in another position.

* *p* < .05.

** *p* < .01 (2-tailed).

Table 3

Sample sizes, sample proportions, means, and standard deviations of the study variables per day.

	Day 1 imp.		Day 1				Day 2				Day 3				Day 4				Day 5			
	% ₁	M	n	% ₁	M	SD	n	% ₁	M	SD	n	% ₁	M	SD	n	% ₁	M	SD	n	% ₁	M	SD
Age	–	40.61	49	–	40.61	8.53	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gender ^a	21.2	–	48	20.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Degree	–	1.74	47	–	1.72	0.80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
ANSP work experience	–	16.37	49	–	16.37	8.22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Regional unit ^b	26.5	–	49	26.5	–	–	18	22.2	–	–	8	25.0	–	–	6	33.3	–	–	5	20.0	–	–
Tower 1 ^b	18.4	–	49	18.4	–	–	18	22.2	–	–	8	12.5	–	–	6	33.3	–	–	5	40.0	–	–
ATC center 2 ^b	10.2	–	49	10.2	–	–	18	27.8	–	–	8	25.0	–	–	6	16.7	–	–	5	40.0	–	–
Intermediate shift ^c	12.2	–	49	12.2	–	–	18	0.0	–	–	8	0.0	–	–	5	0.0	–	–	5	0.0	–	–
Late shift ^c	32.7	–	49	32.7	–	–	18	44.4	–	–	8	0.0	–	–	5	40.0	–	–	5	20.0	–	–
Night shift ^c	28.6	–	49	28.6	–	–	18	44.4	–	–	8	37.5	–	–	5	0.0	–	–	5	0.0	–	–
Week vs weekend shift ^d	24.5	–	49	24.5	–	–	18	38.9	–	–	8	25.0	–	–	5	0.0	–	–	5	20.0	–	–
Tower controller ^e	20.4	–	49	20.4	–	–	18	16.7	–	–	8	25.0	–	–	6	33.3	–	–	5	40.0	–	–
Approach controller ^e	20.4	–	49	20.4	–	–	18	22.2	–	–	8	12.5	–	–	6	16.7	–	–	5	20.0	–	–
Area controller ^e	38.8	–	49	38.8	–	–	18	38.9	–	–	8	50.0	–	–	6	33.3	–	–	5	40.0	–	–
Servant leadership	–	4.94	44	–	4.94	1.13	13	–	5.07	1.39	7	–	4.96	0.68	5	–	4.94	0.75	4	–	5.36	0.72
Trustworthiness	–	5.57	44	–	5.58	1.21	13	–	5.13	1.81	7	–	4.71	1.30	5	–	5.20	0.77	4	–	5.67	0.67
LMX	–	5.64	41	–	5.65	0.82	13	–	5.10	1.07	7	–	5.07	0.66	5	–	5.05	0.76	4	–	5.44	0.92
Supervisor support for safety	–	5.33	41	–	5.33	0.96	13	–	5.13	1.24	7	–	4.95	1.41	5	–	5.20	0.69	4	–	5.42	0.79
Safety compliance	–	4.45	45	–	4.48	0.64	13	–	4.40	0.68	7	–	4.42	0.94	5	–	4.84	0.36	5	–	4.60	0.79
Safety citizenship behavior	–	2.68	47	–	2.68	0.79	13	–	2.89	0.53	7	–	2.27	0.65	5	–	3.00	0.80	5	–	2.60	0.83

Note. Age, gender, degree, and ANSP experience were only assessed at day 1. Day 1 to 5 present the descriptives of the original data, while *Day 1 imp.* presents the descriptives of the pooled imputed data of day 1 ($N = 49$; pooled data does not deliver *SDs*).

%₁ refers to the valid percentage of respondents scoring '1' on the variable.

^a Gender is coded as 0 for males and 1 for females.

^b The unit variables are dummy-coded, such that 1 refers to employees working in the respective unit and 0 to employees working in another unit.

^c The shift variables are dummy-coded, such that 1 refers to employees working in the respective shift and 0 to employees working in another shift.

^d Week vs. weekend shift is coded as 0 during the week and as 1 during the weekend.

^e The position variables are dummy-coded, such that 1 refers to employees working in the respective position and 0 to employees working in another position.

Table 4

Hierarchical multiple regression analyses predicting safety compliance and safety citizenship behavior from servant leadership, trustworthiness, LMX, and supervisor support for safety.

Model		DV: Safety compliance				DV: Safety citizenship behavior			
		<i>b</i> (SE)	<i>t</i>	\bar{R}^2	$\Delta\bar{R}^2$	<i>b</i> (SE)	<i>t</i>	\bar{R}^2	$\Delta\bar{R}^2$
Step 1	(Constant)	4.35*** (0.32)	13.47	0.20		3.03*** (0.45)	6.69	0.11	
	ANSP work experience	0.03* (0.01)	2.55			0.01 (0.01)	0.99		
	Week vs. weekend shift	−0.25 (0.19)	−1.33			−0.46 (0.26)	−1.77		
Step 2	(Constant)	4.30*** (0.72)	5.98	0.24	0.04	2.33* (0.99)	2.36	0.24	0.13
	ANSP work experience	0.03* (0.01)	2.35			0.01 (0.01)	0.89		
	Week vs. weekend shift	−0.30 (0.20)	−1.51			−0.45 (0.27)	−1.70		
	Servant leadership	0.17 (0.15)	1.18			0.39 (0.21)	1.83		
	Trustworthiness	−0.08 (0.13)	−0.59			−0.37* (0.19)	−2.01		
	LMX	−0.03 (0.14)	−0.23			0.06 (0.19)	0.29		
	Supervisor support for safety	−0.03 (0.11)	−0.25			0.11 (0.16)	0.69		

Note. DV = Dependent variable; *N* = 49 (pooled imputed data of day 1).

* *p* < .05.

*** *p* < .001.

Table 5

Overview of employees who have been invited and who participated in interviews.

Invited	Participated
Director's committee	Director's committee (group interview)
Human factors specialists (<i>n</i> = 2)	Human factors specialists (<i>n</i> = 2; group interview)
HR department	One employee of the HR department
Safety department	15 employees of the safety department (group and two individual interviews)
ATS employees and supervisors	One ATC center 1 supervisor
Senior managers	One senior manager
Senior potentials (ATCOs and/or supervisors with a coordinating, management-supporting role)	Three senior potentials (individual interviews)

have operational management responsibilities. They manage the operations to aim for operational excellence, for example by coordinating with other units and stakeholders and striving for long-term operational improvements. Senior potentials receive management training and link senior managers and operations, while still working as air traffic controllers and/or supervisors. The existence of these functions may lead to a diffusion of leadership between them and supervisors. For example, one interviewee was convinced that ATS employees would rather approach the ops-coordinators than their supervisor when experiencing personal problems.

Moreover, the interviews indicated that ATS employees work more closely together with their colleagues and are more dependent on them than on supervisors. Specifically, while two interviewees did find feedback from supervisors useful, three interviewees thought that feedback from colleagues was more important, as colleagues would have a better view on ATS employees' behavior or supervisors do not have the knowledge of the needed behavior or the needed overview of the traffic situation. It is striking that ATS supervisors seem to be perceived as not having enough knowledge of the needed behavior and/or situation at hand. This resembles the specificity of the ATC context, where ATS employees have the best picture of the traffic they are responsible for. It may highlight the difficulty for a supervisor to take up their leadership role and have an impact on ATS employees.

4.3.3. ATS employees' needs from supervisors

Interviewees who either currently worked or in the past had worked as ATS employees and/or supervisors were asked what ATS employees need from their supervisors. They answered that supervisors need to provide guidance and ensure that ATS employees can perform their work under ideal circumstances (e.g., ideal aircraft capacity). Moreover, supervisors should provide support, in general and even more so for

OJTs. More direct communication between supervisor and ATS employees was also mentioned as supporting factor.

4.3.4. Other factors and constraints

Safety citizenship behavior may be restricted by organizational constraints as mentioned during the interviews and by an ATS employee in an open comment field at the end of the survey: "while safety is important and it is a constant thing 'to do', its not something we literally work on all day to improve, there is an operational and management limit to this, and there is clearly no use in pushing further since reports are ignored and there is never feedback received. we continue to do our job safely, even though we try and have tried fruitlessly to address some issues, to no avail" (sic). These organizational constraints that seem to discourage safety citizenship behavior may lead to a difficulty for supervisors to promote ATS employees' safety citizenship behavior.

Repeatedly, interviewees mentioned the significant differences of the supervisor role and system in the different units. It is possible that these differences lead to leadership – safety behavior relationship discrepancies between units. Indeed, in the regional units, supervisors have a preliminary coordinating/organizing role and are not present in the operational room during their supervisor shifts, while in the largest tower unit and the ATC center, supervisors have an operational role and are present in the operational room. The relationship between leadership and safety may depend on the supervisor role and circumstances.

4.3.5. How to support supervisors

Finally, it was also discussed how ATS supervisors may be supported in their role. Most often, organizing adequate training and/or coaching for ATS employees who become supervisors was suggested. Indeed, ATS employees often become supervisor based on their experience, often lacking knowledge and/or skills in leadership. A second aspect that has been mentioned to support supervisors was to increase their role clarity by delineating what is expected of them and include leadership aspects to their role definition by adding them to the operations manual or job descriptions.

5. Discussion

The purpose of the current research was to examine the relationship between different leadership aspects at the supervisor level and employees' safety behavior in the air traffic control (ATC) context. We focused on servant leadership, trustworthiness, leader-member exchange (LMX), and supervisor support for safety on the one hand, and air traffic safety (ATS) employees' safety compliance and safety citizenship behavior on the other hand.

5.1. Theoretical implications

First of all, none of the hypothesized relationships were supported. Most likely, the low response rate and consequently low power possibly account for the non-significant findings. Unpublished survey data from 228 ATS employees of the air navigation service provider (ANSP) where the current study took place showed a negative relationship between ATS employees' fatigue and respectively trust in ($r = -0.19, p < .01$) and servant leadership of top management ($r = -0.21, p < .01$).⁵ Therefore, as even the more distant top management seems to relate to ATS employees' safety aspects (i.e., fatigue), this would warrant a closer examination of immediate supervisors, too. Moreover, interviewees suggested that ATS employees would need guidance and support from their supervisors (especially on-the-job trainees) as well as the provision of ideal circumstances. This could be resembled by servant leadership and, therefore, would suggest a relationship between servant leadership and ATS employees' safety behavior, which could not be detected in the data. Hence, the low sample may indeed account for the unsupported findings.

Alternatively, it may be that in the specific ATC context, different processes play a role than in other industries. Our findings may suggest that in ATC either other agents are more likely to be main sources of role modeling and social exchange, or the outcomes of the two processes are different from safety behavior. For example, ATS employees' safety behavior may be more strongly related to the behavior of operations-coordinators, senior potentials, or colleagues than to the behavior of the supervisor on that particular day (given that supervisors rotate). As suggested during the interviews and also noticed during the first author's observations of the operations, ATS employees do indeed work more closely together with their colleagues than their supervisors. In the literature, it has been argued that in settings where colleagues are proximately closer than supervisors, colleagues have a strong referent and expert power, and the supervisor is not always available (which indeed is true for ATC), the safety communication of colleagues may be more salient than that of supervisors (Tucker et al., 2008). This may position colleagues more likely to become role models and/or social exchange partners in ATC. Moreover, the outcomes of role modeling and social exchange may be more directed towards the supervisor or colleagues, reflecting aspects such as trust, commitment, and cooperative or friendly behavior.

Furthermore, the interview results suggest that ATS supervisors' role definition may scarcely include leadership aspects due to various possible reasons. The rotating leadership system in some units, the related difficulty of the transition from colleague to supervisor, and the lack of leadership tasks in supervisor job descriptions and trainings were all mentioned during the interviews and may possibly relate to role unclarity and perceptions that the supervisor role does not imply leadership. Moreover, the co-existence of other job functions with a potential leadership role (i.e., operations-coordinators and senior potentials) may diffuse supervisors' leadership responsibility. In turn, this unclarity and lack of leadership in the role definition may hinder a relationship between supervisors' leadership aspects and ATS employees' safety behavior. This would be in line with findings from the literature showing that the extent to which supervisors' role definition includes responsibility for employees' safety behavior and safety relates positively to supervisors' safety leadership (Conchie et al., 2013), supervisors' safety-related interactions with employees, and employees' safety compliance (Zohar and Luria, 2003).

Not only may organizational factors restrict supervisors' leadership, but they may also restrict employees' safety behavior, as mentioned during the interviews using the example of the organization's limited processing of safety-related suggestions that would discourage making

safety-related suggestions, a safety citizenship behavior. The literature, too, corroborates the importance of organizational factors for employees' safety behavior (Beus et al., 2016). Consequently, organizational constraints may also hinder the relationship between supervisors' leadership and ATS employees' safety behavior. For example, if ATS employees have the impression that the safety-related suggestions they make are not processed by the organization, a supervisor may not be able to stimulate safety-related suggestions. However, the current study's data indicates that ATS employees do enact safety citizenship behavior (to some extent) on a daily basis, with means ranging from 2.27 to 3.00 (on a scale from 1 (*never*) to 5 (*very frequently*)) on different days. Nevertheless, the moderating role of organizational constraints warrants further investigation.

Surprisingly, the results indicate that trustworthiness is associated with *lower* safety citizenship behavior. As the correlation between trustworthiness and safety citizenship behavior is nearly 0, it seems to be important to test trustworthiness together with the control variables and the other leadership aspects in one model. That way, we controlled for the overlap between the leadership aspects and discovered the negative relationship between the unique part of trustworthiness and safety citizenship behavior. A reason for this negative relationship might be that ATS employees believe trustworthy supervisors take care of everything, and thus enact lower safety behavior themselves. Indeed, trust in the supervisor may decrease the perception of risk at the workplace (Kivimäki et al., 1995), which, in turn, relates to lower safety compliance and safety participation (Xia et al., 2017). Moreover, scholars have found that too much trust can have negative effects for performance, either by arguing for a curvilinear relationship between trust and performance, or for negative effects of trust besides its positive effects (Bammens and Collewaert, 2014). This has also been confirmed in safety research, where "blind trust [...] would be detrimental for safety" (Tharaldsen et al., 2010). Completely trusting others may increase the risk for safety incidents due to a reduced personal responsibility for safety and, by consequence, a reduced alertness towards unsafe conditions (Conchie and Donald, 2008). Generally, excessive trust is closely associated with blind faith and unchallenged loyalty (Stevens et al., 2015). Possibly, in ATC, a social exchange mechanism is in place where trustworthiness of the supervisor is replied with blind faith or unchallenged loyalty of ATS employees. Indeed, scholars investigating ATS employees' trust in automation found that too much trust may lead to overreliance or a reduced vigilance (Corver and Aneziris, 2015). This may also hold true for too much trust in the supervisor.

Another finding was that all investigated leadership aspects are highly related with each other. This corresponds with empirical findings in the literature, reporting a high overlap, yet conceptual distinctiveness, between LMX and trust (Dirks and Ferrin, 2002), LMX and servant leadership (Liden et al., 2008), and servant leadership and trust (Schaubroeck et al., 2011). The relationships between these leadership aspects and supervisor support for safety have not been investigated in the literature so far. Our findings suggest that in ATC, not only the general leadership aspects LMX, servant leadership, and trustworthiness are interrelated, but that they are also strongly related to supervisor support for safety. The implication is that leadership would benefit from a holistic approach (Meuser et al., 2016) and that leaders need to excel at different fronts.

Similarly, the strong relationship, yet distinctiveness between ATS employees' safety compliance and safety citizenship behavior corresponds with earlier empirical evidence of a strong association between both safety behaviors in other industries (Clarke, 2012). Thus, in ATC, too, safety compliance and safety citizenship behavior should be distinguished as two related, but discrete behaviors. Another reason to differentiate between both is that trustworthiness seems to be related to one but not both of the behaviors. This suggests that different relationships with leadership are in place for safety compliance and safety citizenship behavior.

ATS employees' safety behavior is not only important for the clear

⁵ Additional information about the method of this data collection can be found in Appendix A.

benefits of a safe airspace, but also for the performance of ANSPs, as safety and performance are closely related in ATC (Griffin et al., 2000). This also informs the safety literature in such that safety behavior need not necessarily be adjacent to performance, but may also align with performance. Hence, the often-discussed discrepancy between safety behavior and performance (e.g., when safety features and material hinder performance) is not of importance in ATC. This would make the ATC environment an ideal research context because factors that predict safety will not be confounded with concerns for performance, because safe behavior is, in fact, performance. Even though perceptions of the discrepancy between safety and performance exist, research highlighted that even for industries that are usually thought of in terms of having a trade-off between safety and operations, safety also benefits operations and business performance (Veltri et al., 2013). This also opens the discussion in the safety literature as whether safety behavior and its predictors can be considered consistent with task performance predictions or with contextual performance. This would allow for further theorizing on safety behavior as task performance as opposed to safety behavior as contextual performance (that is, not essential for task performance). Research is needed to identify whether the mechanisms that operate for predicting safety are similar in contexts in which safety equates with task performance as compared to contexts in which safety is an additional requirement on top of performance.

5.2. Practical implications

From a practical point of view, the current research aimed to contribute to our knowledge on which leadership aspects may be important for supervisors to ensure ATS employees' safety compliance and safety citizenship behavior. Some might argue that ATS employees do not need to enact safety citizenship behaviors because they behave completely safety compliant and this is what they need to focus on due to the urgent nature of their job. Indeed, air traffic controllers are less likely to enact contextual performance, under which safety citizenship behavior can be categorized, in difficult situations due to urgent task demands (Griffin et al., 2000). Yet, both task and contextual performance contribute to ATS employees' perceived effectiveness (Griffin et al., 2000). A situation where the importance of safety citizenship behavior in ATC becomes very clear is the moment of position handover, when one ATS employee takes over from a colleague. In many ATS cultures and ANSPs from many different countries, there have been persistent problems associated with position handover, including omitting critical information leading to incidents shortly after. Even though conducting briefings during handover is expected from ATS employees, putting extra effort into helping colleagues and following up that the handover was successful is regarded safety citizenship behavior.⁶ Our data, moreover, shows that ATS employees enact safety citizenship behavior (to some extent) on a daily basis.

The negative relationship between supervisors' trustworthiness and ATS employees' safety citizenship behavior implies that one needs to look at supervisors' trustworthiness with caution. Although a closer additional examination of this relationship is warranted, ANSPs might want to take into account the difficulties associated with supervisors' trustworthiness. The proper conditions should be investigated and created, under which supervisors' trustworthiness may be positive for safety. Besides trustworthiness, a moderate amount of distrust leading to checking and monitoring others' behavior, may be needed to promote safety behavior (Conchie and Donald, 2008). Indeed, if too much trust impedes acting or providing information (i.e., safety behavior), it can have detrimental consequences, as has been shown in research on interactions in aircraft cockpits (Schöbel, 2009).

The fact that we did not find any evidence for a positive relationship between supervisors' leadership aspects and ATS employees' safety

behavior might lead to the conclusion that ANSPs may better focus on aspects other than leadership if wanting to increase ATS employees' safety behavior. However, as the results may have occurred due to the low power, it is still noteworthy to look at how supervisors could be supported to enact leadership behaviors that may be supportive for safety. Moreover, if it is true that there is currently no relationship between supervisors' leadership and employees' safety behavior, the question may be raised whether and how such a relationship should be established. Indeed, during the interviews, some ATS employees mentioned that it is not the role of supervisors to be their "leader". For example, feedback from their supervisor was said to be little valuable as supervisors would not have a good view on ATS employees' behavior and they would not always have the knowledge of the needed behavior. Yet, in other industries, providing feedback is a crucial task of supervisors, increasing employees' performance and safety behavior (Zohar and Luria, 2003). In our sample, ATS supervisors have many operational and organizing tasks, such as deciding about the correct runway or contacting backup-employees in case of illnesses. However, their job descriptions and training currently scarcely include leadership aspects. This aligns with the current attitude ATS employees have towards supervisors, as supervisors do not add much in terms of leadership, notwithstanding that ATS employees favor a servant leadership style. This would indicate that supervisors currently are withheld from fully engaging as leaders and take up the full range of leadership behaviors that are able to positively encourage ATS employees' safety behavior.

To date, empirical evidence concerning antecedents of leadership characteristics that are related to employees' safety behavior remains scarce (Conchie et al., 2013). Conchie et al. (2013) conducted focus groups with construction supervisors and found that social support and autonomy concerning leadership seem to be the most important factors helping supervisors in enacting safety-effective leadership. The authors recommend supportive environments or "providing training that equips supervisors with the necessary interpersonal skills in how to approach employees about safety". The suggestions on how to support ATS supervisors that came up during the interviews may indicate additional pathways to stimulate safety-effective leadership. First, organizing adequate training and/or coaching for ATS supervisors may be relevant. This is supported by the findings of Conchie et al. (2013) in the construction industry, where supervisors indicated that their engagement in safety leadership was promoted when being equipped with the necessary knowledge, skills, and tools. Moreover, leadership interventions have proven their effectiveness in the safety literature, as leadership interventions have successfully improved supervisors' leadership and employees' safety behavior (Gravina et al., 2019; Kelloway and Barling, 2010). Second, it may be important to increase ATS supervisors' role clarity and include leadership aspects to their role definition. Zohar and Luria (2003) found that adapting supervisors' role definition to include employees' safety behavior increased supervisors' safety-oriented interactions with employees and subsequently employees' safety behavior. Thus, improving supervisors' role clarity and adding leadership characteristics to it might support supervisors and ATS employees' safety behavior. Role clarity could, for example, be increased by clarifying job descriptions (Bowling et al., 2017).

When wanting to address supervisors' leadership aspects, it must be taken into account that supervisors think their leadership qualities are perceived as more favorably than they are actually perceived by ATS employees (Coetzee and Henning, 2019). Thus, supervisors' awareness concerning how they are perceived may need to be sharpened.

5.3. Limitations and future research

A main limitation of the current research is the low participation and high drop-off rate. Consequently, the results may be biased, as the statistical power turned out to be low. Moreover, given the low sample size, the planned analyses could not be performed. By consequence, we used a cross-sectional design, which inherits the risk of common-method bias,

⁶ We thank an anonymous reviewer for pointing this out.

as independent and dependent variables were measured in the same way and at the same moment and rated by the same individuals (Podsakoff et al., 2003). Therefore, additional research with a larger sample size and multiple methods and/or sources needs to be conducted. Moreover, experimental designs would be valuable, as our design does not allow for any causal inferences. As argued for above, future research may also study colleagues as alternative role models and social exchange partners in ATC.

Future research may also want to focus on the training period, in which more senior air traffic controllers, called on-the-job training instructors (OJTIs), oversee novice air traffic controllers, called on-the-job trainees (OJTs). It would be interesting to investigate the relationship between OJTIs and OJTs, as role modeling may be crucial in this relationship. As such, a trickle-down of servant role modeling may occur from supervisor to OJTI and subsequently from OJTI to OJT. Moreover, comparing the impact of supervisors versus OJTIs on OJTs' and other ATS employees' safety behavior would be relevant. Indeed, it may be that the importance of safety behaviors is especially addressed during the training period by OJTIs. Another valuable approach would be to take a step back and conduct more exploratory qualitative research on the topic. While we did conduct informal interviews with various employees, many of them working or having worked as ATS employees and/or supervisors, an extension of this research is needed. A possibility would be to conduct focus groups with ATS employees and supervisors to ask them how and why they think they could and do influence each other.⁷

Another limitation is that the current research was limited to one ANSP, restricting the generalizability of the findings to other contexts, including other industries or cultures (Mirza and Isha, 2017). Yet, the advantage of performing the study in one ANSP only is an enhanced control of the context. Moreover, we controlled for the impact of the unit, because even in the same country, different ATC units can behave in markedly different ways. This was also mentioned during the interviews, as interviewees repeatedly emphasized the differences in leadership systems between units that may lead to diverging findings. Our sample was not large enough to conduct analyses separately for different units or leadership systems. Future research should differentiate between different supervisor systems and roles and, as such, take the context even more into account. Moreover, future research is needed to take into account cultural and/or regional differences, which may direct ATC employees' safety behavior. In particular, the relations between management and supervisors is culturally dependent (Dickson et al., 2012) and hence, more knowledge on how these cultural elements play in ATC is highly relevant. Finally, as mentioned during the interviews, organizational factors may constraint ATS employees' safety behavior and/or supervisors' leadership, and should, therefore, also be taken into account in future research.

Additionally, factors that we did not investigate may influence the relationship between leadership and ATS employees' safety behavior. For example, Griffin et al. (2000) found indications that in difficult situations (among others in terms of traffic volume and complexity, weather conditions, and pilot actions), air traffic controllers are less likely to enact contextual performance due to urgent task demands. We did investigate the role of the shift as control variables as we expected situational difficulty in terms of traffic volume and complexity to vary systematically between the type of shift (week or weekend and early, intermediate, late, or night shift). However, factors such as weather conditions and pilot actions influencing the situational difficulty are largely independent of the type of the shift. Therefore, future research needs to consider the situational difficulty more directly.

Future research should also investigate how safety-effective leadership behaviors and characteristics may be supported. That research may build forth on our interview insights and investigate whether the

training and/or coaching for (ATS) supervisors and/or increasing their role clarity may facilitate safety-effective leadership behaviors.

Finally, while we suggested and elaborated on theoretical mechanisms to explain the expected relationships between leadership and employees' safety behavior, we did not explicitly test those mechanisms. Additional research is needed that empirically tests for reciprocity and role modeling as mediating mechanisms. Similarly, while we tested the direct relationships between leadership aspects and safety behavior, we did not elaborate on the interrelations between the leadership aspects. Indeed, we found high correlations between the leadership aspects, which may indicate that they tend to co-occur, but also may indicate that some leadership aspects may explain others. For example, the constructive leadership style safety-related transformational leadership has been found to relate to safety citizenship behavior via trust in the leader (Conchie et al., 2012). Furthermore, high-quality LMX and trust have been shown to mediate the relationship between servant leadership and favorable employee behaviors (Van Dierendonck, 2011). In an ATC context, this needs further replication. Moreover, safety-related mediators would be interesting to investigate. In the literature, safety climate and employees' safety knowledge, motivation, and skills are often brought forward as mediators between leadership and employees' safety behavior (Christian et al., 2009; Clarke, 2013). As Hoffmeister and colleagues (2014) formulate it: "greater attention should be paid to the mechanisms by which leaders influence safety".

6. Conclusions

The current research aimed to understand the role of supervisors' leadership aspects in ATS employees' safety compliance and safety citizenship behavior. It creates a foundation for further research in two ways. First, the conceptual model based on social learning theory, social exchange theory, and a consolidation of empirical findings forms a useful framework for further research. Second, the applied method and the research results form a starting point that invites researchers to further develop our knowledge on the role of supervisors' leadership in ATC. This is especially important as "the aviation industry is particularly unforgiving of safety limits" (Coetzee and Henning, 2019).

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: This work was supported by the Belgocontrol Chair on Human Factors and Leadership in Aviation Safety from the KU Leuven. The research topic was defined in mutual deliberation between funding source Belgocontrol (now keyes) and researchers. While study design and collection were developed by the researchers, the funding source had minor input in these aspects as well. However, the funding source was not involved in the analysis, interpretation of data, writing of the report, and the decision to submit the article for publication. The research is disinterested and conducted impartially.

Appendix A. Method of additional data collection

All air traffic controllers, on-the-job-trainees, and supervisors of a European ANSP (the same as where the current data collection was conducted) were invited to participate in a survey study at the end of a training session. Out of 233 employees, 228 participated, which corresponds to a response rate of 97.9%. One participant was excluded from the analyses, because the participant felt the questions did not relate to the specific job tasks.

All items were rated on a scale from 1 (*strongly disagree/never*) to 7 (*strongly agree/always*). Servant leadership of top management was measured using the seven-item short form of the servant leadership measure (Liden et al., 2008). The dimension "creating value for the community" was excluded as it was deemed irrelevant for the context,

⁷ We thank an anonymous reviewer for these valuable suggestion.

such that six items remained. To tailor the items to the context, the word “manager” was replaced by “management”. An example item is: “I would seek help from my management if I had a personal problem”. The scale’s Cronbach alpha is 0.79.

To measure trust in management, a ten-item scale of Mayer and Gavin (2005) was used, of which an example item is “I would be willing to let my management have complete control over my future in this company”. Cronbach’s alpha for that scale is 0.69.

Fatigue was measured with a eleven-item scale of Van Yperen and Janssen (2002). “Working day” was replaced by “shift” and an example item is: “I find it difficult to relax at the end of a shift”. The scale’s Cronbach alpha is 0.91.

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