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Transformational Leadership and Procedural Compliance: A Four-Wave Mediation Study of Job Demands, Coworker Support, and Job Satisfaction

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Highlights

Public health relevance—How does this work relate to a public health issue?

- Non-compliance with workplace procedures may contribute to accidents, injuries, and other adverse occupational health outcomes.
- This study examines organizational and psychosocial factors associated with general procedural compliance, which may be relevant to occupational public health and accident prevention.

Public health significance—Why is this work of significance to public health?

- This four-wave study identifies time-lagged direct and indirect associations between transformational leadership, psychosocial work conditions, job satisfaction, and later general procedural compliance.
- Job satisfaction was an important intervening variable linking leadership and psychosocial work conditions with later procedural compliance.

Public health implications—What are the key implications or messages for practitioners, policy makers and/or researchers in public health?

- Workplace compliance initiatives should consider psychosocial work conditions in addition to formal procedures and rules.
- Organizational efforts to support general procedural compliance should consider transformational leadership, quantitative job demands, coworker support, and job satisfaction.

Abstract

Moving beyond the traditional focus on safety-specific compliance, this study examines general procedural compliance across diverse work settings. Integrating transformational leadership theory and the Job Demands–Resources model, we investigated time-lagged associations between transformational leadership at T1, coworker support and quantitative job demands at T2, job satisfaction at T3, and procedural compliance at T4 (time lags of six, six, and twelve months, respectively). Four-wave panel data collected over two years included 3613 Norwegian employees who participated in at least one wave. Missing data were handled using multiple imputation and the model was estimated using WLSMV, treating the ordinal indicators and single dichotomous compliance outcome categorically. Transformational leadership was positively associated with subsequent coworker

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support and negatively associated with quantitative job demands. Transformational leadership and coworker support were positively associated with later job satisfaction, whereas quantitative job demands were negatively associated with it. In the primary model, both transformational leadership and job satisfaction were positively associated with later procedural compliance. Significant indirect associations between transformational leadership and compliance were found through coworker support and job satisfaction, and, to a smaller extent, through quantitative job demands and job satisfaction. After controlling for T3 compliance, job satisfaction remained positively associated with T4 compliance, and the total indirect association between transformational leadership and compliance remained significant. However, neither the direct nor the total association between transformational leadership and compliance was statistically significant in this specification. The findings support a temporally ordered mediation model linking transformational leadership and psychosocial work factors to later self-reported general procedural compliance. Although accidents were not measured, procedural compliance may be relevant to occupational public health as one of several organizational factors potentially associated with adverse occupational outcomes.

Keywords: procedural compliance; transformational leadership; occupational health; job satisfaction; quantitative job demands; coworker support

1. Introduction

Accident investigations consistently identify non-compliance with procedures as a central contributory factor in both minor incidents and major industrial disasters [1,2]. Historical events such as the Chernobyl nuclear catastrophe, the Piper Alpha offshore platform disaster, and the BP Texas City refinery explosion illustrate how deviations from established procedures can escalate into catastrophic outcomes [3–5]. Following Chernobyl, systematic safety research emerged with a strong focus on identifying the causes of rule violations in high-risk industries [6,7]. More recently, however, attention has increasingly shifted toward understanding the organizational conditions that promote compliance with procedures rather than those that merely explain violations [8].

Beyond organizational performance, occupational accidents represent a major public health concern because they contribute substantially to injury, disability, sickness absence, and premature mortality worldwide. Understanding how organizations can promote sustained procedural compliance therefore has implications not only for organizational effectiveness but also for public health through improved accident prevention.

Within safety science, compliance has traditionally been conceptualized as *safety compliance*, defined as employees' adherence to safety rules, instructions, and procedures related to safe work practices [9]. This body of research has produced valuable insights, particularly regarding the influence of safety climate, leadership, and work pressure on safety-related behavior. However, a strict focus on safety-specific compliance risks oversimplifying how procedures operate in contemporary organizations. In practice, safety procedures are embedded within broader systems of operational, quality, and efficiency-related rules, where adherence to one set of procedures often shapes adherence to others, with important consequences for both risk management and performance [10]. Examining safety compliance in isolation may therefore obscure key organizational dynamics and promote a narrow, instrumental form of rule-following rather than sustained and meaningful engagement with procedural integrity.

Building on this critique, the present study adopts a broader perspective by examining *procedural compliance* more generally. Compliance is here understood as employees' consistent adherence to organizational procedures, rules, and standards that govern everyday work practices. This broader conceptualization recognizes that many procedures—whether labeled as "safety," "quality," or "efficiency"—have indirect but meaningful implications for employee well-being, risk exposure, and organizational performance. For example, poorly designed workflows, excessive time pressure, or lack of support can undermine both motivation and the feasibility of complying with procedures, regardless of whether those procedures are explicitly framed as safety-related. As demonstrated by Olsen et al. [10], general compliance has longitudinal links to critical safety outcomes, such as reduced hydrocarbon leaks in offshore environments, underscoring the value of moving beyond a narrow safety-only focus.

Understanding procedural compliance therefore requires attention to the psychosocial conditions under which employees work. One influential framework for examining such conditions is the Job Demands–Resources (JD–R) model [11]. The JD–R model explains how job demands (e.g., workload, time pressure) and job resources (e.g., social support) jointly shape employee well-being and performance. Importantly, this framework offers a theoretically grounded way of explaining why employees may struggle to comply with procedures when demands are excessive or resources insufficient, and how supportive work environments can foster sustained adherence. In this study, the JD–R model is explicitly applied as a framework for understanding compliance, rather than being treated as a general model of well-being detached from procedural behaviour.

Leadership plays a central role in shaping both job demands and job resources within the JD–R framework [12,13]. In particular, transformational leadership has been shown to enhance social support, reduce perceived work pressure, and increase employee motivation and satisfaction. While previous research has often examined safety-specific transformational leadership in relation to safety compliance, emerging evidence suggests that general transformational leadership and safety-specific leadership are highly overlapping and similarly related to compliance-related outcomes [14]. This raises the question of whether general transformational leadership can foster procedural compliance across diverse work settings, including sectors not traditionally classified as high-risk.

A further limitation of existing research is its heavy reliance on cross-sectional designs. Compliance, job demands, and job satisfaction may vary over time as employees interact with leaders, colleagues, and organisational systems. Longitudinal research is therefore valuable for examining the temporal ordering of associations between leadership, work conditions, and compliance behavior. Recent qualitative research has highlighted the relevance of employee engagement to the relationship between leadership, work conditions, and compliance [15]. The present study examines job satisfaction as a potential mediator in these relationships using data collected across multiple waves.

The present study addresses this gap by examining time-lagged associations with self-reported general procedural compliance using four waves collected over two years, with successive time lags of six, six, and twelve months. Integrating transformational leadership theory with the JD–R model, we examine whether transformational leadership at T1 is associated with coworker support and quantitative job demands at T2, whether these factors are associated with job satisfaction at T3, and whether job satisfaction is associated with procedural compliance at T4. We also examine the direct and indirect associations between transformational leadership and later compliance. By focusing on general rather than safety-specific procedural compliance and drawing on employees across sectors in Norway, the study extends compliance research beyond traditionally high-risk settings.

2. Theoretical Background

2.1. Procedural Compliance as an Organisational Outcome

Within safety science, compliance has traditionally been conceptualised as safety compliance, referring to employees' adherence to safety rules, instructions, and procedures related to safe work practices [9]. This research has identified associations between safety climate, leadership, work pressure, and safety compliance [8,16,17]. However, safety procedures are typically embedded within broader organisational systems that also govern quality, efficiency, and everyday work processes. Procedural compliance may therefore also be examined as a broader organisational outcome rather than exclusively as a safety-specific behaviour [10].

Accordingly, the present study defines general procedural compliance as employees' adherence to workplace procedures across different work settings. This broader perspective recognises that procedures aimed at safety, quality, and operational performance are often closely interconnected. Consistent with this view, previous longitudinal research indicates that general procedural compliance is associated with important safety outcomes, including reduced hydrocarbon leaks in offshore operations [10]. Examining procedural compliance more broadly may therefore provide a more comprehensive understanding of organisational factors associated with general adherence to workplace procedures, which may also have implications for accident prevention.

2.2. The Job Demands–Resources Model as a Framework for Compliance

Understanding procedural compliance requires attention to the psychosocial conditions under which employees perform their work. The Job Demands–Resources (JD–R) model [11] provides a widely used framework for explaining how job characteristics are associated with employee well-being and performance. According to the JD–R model, job characteristics can be categorised as either job demands or job resources. Job demands refer to physical, psychological, social, or organisational aspects of work that require sustained effort and are associated with physiological or psychological costs (e.g., workload, time pressure). Job resources, in contrast, are aspects of the job that support goal attainment, reduce the impact of demands, or foster learning, growth, and motivation (e.g., social support, autonomy).

The JD–R model proposes two core processes. Excessive job demands may initiate a health-impairment process involving strain and reduced functioning, whereas job resources may contribute to a motivational process associated with greater engagement, satisfaction, and performance [18]. Importantly, job resources can buffer the negative effects of high job demands. This dual-process logic makes the JD–R model particularly suitable for examining compliance, as adherence to procedures may be less likely under excessive demands and more likely under supportive work conditions.

Previous research indicates that job demands and resources are relevant to safety-related behaviour. Job resources are positively related to safety compliance [19,20], whereas excessive job demands are associated with safety violations and reduced compliance [21,22]. Extending this logic, the present study applies the JD–R model explicitly as a framework for understanding general procedural compliance more broadly. Specifically, coworker support represents the job resource examined in the study, whereas quantitative job demands represent the job-demand component.

2.3. Transformational Leadership and General Procedural Compliance

Transformational leaders inspire and motivate followers through vision, individualised consideration, and intellectual stimulation [23,24].

Safety research has often emphasised safety-specific transformational leadership in relation to safety compliance [25,26]. However, recent research challenges a strict distinction

between general and safety-specific leadership. Nguyen et al. [14] found that the two forms of leadership were highly correlated and showed similar relationships with compliance-related outcomes. This suggests that general transformational leadership may also be relevant to general procedural compliance, particularly in heterogeneous or lower-risk work settings.

Based on this reasoning, the present study examines whether general transformational leadership is associated with general procedural compliance measured at a later wave. Accordingly, the following hypothesis is proposed:

Hypothesis 1. *Transformational leadership at T1 will be positively associated with general procedural compliance measured at T4.*

2.4. Transformational Leadership, Coworker Support, and Quantitative Job Demands

Leadership can be integrated into the JD–R framework as an organisational factor associated with employees' job demands and job resources [12,13]. This perspective positions leadership as a potential antecedent to employees' perceptions of their psychosocial work environment rather than as a job demand or job resource in itself. Transformational leadership has received particular attention in research connecting leadership with the JD–R framework [13]. Fernet et al. [27] found that transformational leadership was associated with employees perceived job characteristics, supporting the proposition that transformational leadership may be related to both job demands and job resources. In the present study, quantitative job demands represent the job-demand component, whereas coworker support represents the job-resource component. Based on the JD–R framework and previous findings concerning transformational leadership and perceived job characteristics, we expect transformational leadership to be positively associated with coworker support and negatively associated with quantitative job demands at the subsequent wave. Accordingly, the following hypotheses are proposed:

Hypothesis 2. *Transformational leadership at T1 will be positively associated with coworker support at T2.*

Hypothesis 3. *Transformational leadership at T1 will be negatively associated with quantitative job demands at T2.*

2.5. Job Satisfaction as a Potential Intervening Variable

Job satisfaction is an important work-related attitude associated with both leadership and psychosocial work characteristics. Meta-analytic evidence indicates a positive association between transformational leadership and follower satisfaction [28]. Related cross-sectional research on change-oriented leadership has also identified direct and indirect associations with job satisfaction through learning demands and job involvement [29]. Although change-oriented leadership and learning demands differ from the constructs examined in the present study, these findings support the broader proposition that leadership and perceived work characteristics are associated with employee job satisfaction. Within the JD–R framework, job resources are expected to be associated with positive motivational outcomes, whereas excessive job demands are expected to be associated with strain and less favourable work-related outcomes [18]. Applying this logic to the present study, coworker support is expected to be positively associated with subsequent job satisfaction, whereas quantitative job demands are expected to be negatively associated with subsequent job satisfaction. Transformational leadership may also show a direct association with later job satisfaction beyond its associations through these psychosocial work factors.

Previous research also supports examining job satisfaction in relation to compliance. In a qualitative offshore study, Styrvold and Olsen [15] identified work engagement as one possible link between performance feedback and commitment to procedural compliance. Similarly, Masia and Pienaar [30] found a positive association between job satisfaction and safety compliance in a cross-sectional study in the mining industry. Although these studies differ from the present study in design, setting, and conceptualisation of compliance, their findings suggest that job satisfaction may be relevant to employees' adherence to workplace procedures. Based on this literature, the following hypotheses are proposed:

Hypothesis 4. *Transformational leadership at T1 will be positively associated with job satisfaction at T3.*

Hypothesis 5. *Coworker support at T2 will be positively associated with job satisfaction at T3.*

Hypothesis 6. *Quantitative job demands at T2 will be negatively associated with job satisfaction at T3.*

Hypothesis 7. *Job satisfaction at T3 will be positively associated with general procedural compliance at T4.*

2.6. Time-Lagged Indirect Associations

Serial mediation models can be used to examine theoretically ordered indirect associations between leadership, work characteristics, employee attitudes, and organisational outcomes. Katou et al. [31], for example, integrated transformational leadership with the JD–R framework in a serial mediation model involving job demands, job resources, employee well-being, and organisational performance. Although their cross-sectional study did not establish temporal or causal relationships, it illustrates the relevance of examining sequential indirect associations within the JD–R framework.

Building on the preceding arguments, the present study examines whether transformational leadership at T1 is indirectly associated with general procedural compliance at T4 through coworker support and quantitative job demands at T2 and job satisfaction at T3. Separating the constructs across four waves establishes temporal ordering in accordance with the proposed model but does not establish causality or within-person change.

Accordingly, the following hypothesis is proposed:

Hypothesis 8. *Job satisfaction at T3 will mediate the time-lagged associations of transformational leadership at T1, coworker support at T2, and quantitative job demands at T2 with general procedural compliance at T4, including the serial indirect associations of transformational leadership through (a) coworker support and job satisfaction and (b) quantitative job demands and job satisfaction.*

2.7. Research Model

Figure 1 presents the proposed time-lagged model linking transformational leadership at T1, coworker support and quantitative job demands at T2, job satisfaction at T3, and general procedural compliance at T4. The model includes both a direct association between transformational leadership and compliance and indirect associations through the psychosocial work factors and job satisfaction. These temporally ordered associations do not establish causality or within-person change.

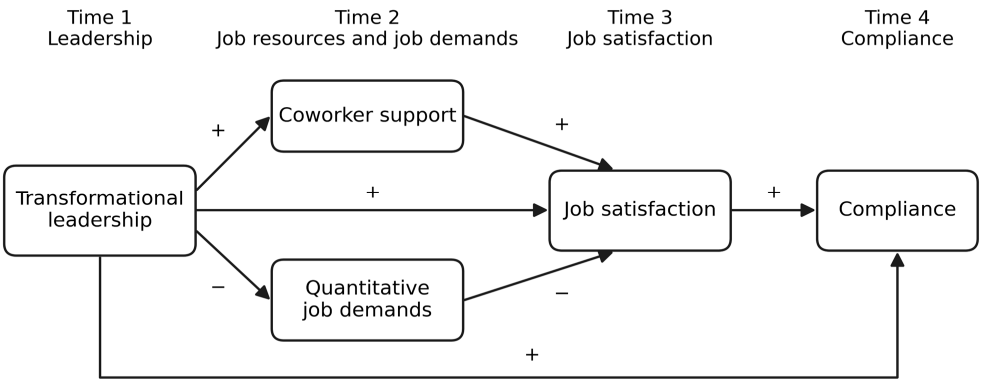


Figure 1. Research model of the current study.

3. Materials and Methods

3.1. Survey and Participants

This study used data from an ongoing online panel of Norwegian employees administered by Norstat. The panel is designed to approximate the national workforce with respect to age, gender, and geographical region, in line with demographics from Statistics Norway, and spans sectors and industries. Data were collected with electronic questionnaires.

In each wave, more than 1500 responses were targeted. To build the longitudinal panel, respondents from earlier waves were invited first, and new participants were added as necessary, resulting in a rotating panel in which each wave combines returning and new respondents. Participant anonymity was maintained through a two-step procedure in which identities were not shared with the researchers. Participants were informed about the study's purpose and their right to withdraw.

The study used four waves of data: T1 (September 2021, n = 1511), T2 (March 2022, n = 1526), T3 (September 2022, n = 1530), and T4 (September 2023, n = 1516). The analytic sample comprises all 3613 individuals who responded to at least one of the four waves; this sample was used for the main analysis, with missing data handled by multiple imputation as described in Section 3.3. Because of the rotating design, 2166 respondents participated in exactly one wave, 736 in two waves, 399 in three waves, and 312 in all four waves; 1511 respondents entered the panel at T1, 831 at T2, 714 at T3, and 557 at T4. The number of respondents observed on any given pair of waves in the structural model ranged from 463 (leadership at T1 and compliance at T4) to 800 (job satisfaction at T3 and compliance at T4); the observed overlap for every pair of study variables is reported in Table S5. The four-wave completers are described alongside the full sample in Table 1 and were used in robustness analyses (Section 3.3). A participant flow diagram is provided in Figure S1. Compared with other T1 respondents, four-wave completers were somewhat older, more often male, and worked slightly more hours ($|d| = 0.13$–0.26), but did not differ on any T1 study variable (all $p \geq 0.35$; Table S1).

Table 1. Demographic characteristics of the analytic sample.

	Full Analytic Sample (N = 3613)	Four-Wave Completers (n = 312)
Gender		
Male	1852 (51.3%)	203 (65.1%)
Female	1761 (48.7%)	109 (34.9%)
Age (years)		
Mean (SD)	44.9 (13.5)	49.1 (12.6)
Weekly working hours		
Mean (SD)	37.8 (9.8)	39.0 (10.4)
Missing	2097	0

Table 1. *Cont.*

	Full Analytic Sample (N = 3613)	Four-Wave Completers (n = 312)
Location in Norway		
North	127 (8.4%)	19 (6.1%)
Middle	209 (13.9%)	42 (13.5%)
West	324 (21.5%)	56 (17.9%)
East	502 (33.3%)	114 (36.5%)
South (incl. Telemark)	111 (7.4%)	30 (9.6%)
Oslo	235 (15.6%)	51 (16.3%)
Missing	2105	0
Education		
Primary school	40 (1.8%)	4 (1.3%)
High school	343 (15.4%)	42 (13.5%)
Vocational school	411 (18.5%)	58 (18.6%)
University/college up to 3 years	686 (30.8%)	99 (31.8%)
University/college 4 years or more	744 (33.5%)	108 (34.7%)
Missing	1389	1

Note: Values are n (%) unless otherwise stated; percentages are based on valid observations. Working hours and location were measured at T4.

3.2. Measures

Unless noted otherwise, items were rated on five-point Likert scales (1 = very seldom or never, 5 = very often or always). Reliability coefficients are based on all available observed data in the analytic sample. The retained and excluded items for each construct are documented in Table S6.

3.2.1. Transformational Leadership (T1)

Transformational leadership was measured with the seven-item Global Transformational Leadership scale [32], covering vision, staff development, supportive leadership, empowerment, innovative thinking, leading by example, and charisma (e.g., "communicates a clear and positive vision of the future"). Internal consistency was high (Cronbach's alpha = 0.95).

3.2.2. Coworker Support (T2)

Coworker support was measured with the three-item support-from-coworkers subscale of the QPS Nordic-ADW ([33]; e.g., "Are your work results appreciated by your work colleagues?"). Because leadership behaviour was already captured by the transformational leadership measure, the superior-support items of the QPS Nordic were not used, keeping the support construct conceptually distinct from leadership. Internal consistency was satisfactory (Cronbach's alpha = 0.80).

3.2.3. Quantitative Job Demands (T2)

Job demands were measured with the three-item quantitative-demands subscale of the QPS Nordic-ADW ([33]; e.g., "Is it necessary to work at a rapid pace?"). The QPS Nordic demands block contains additional items covering decision-making and learning demands; the present study used the quantitative-demands subscale, which corresponds to the demand construct in the theoretical model. Internal consistency was satisfactory (Cronbach's alpha = 0.75).

3.2.4. Job Satisfaction (T3)

Job satisfaction was measured with four items administered at T3 on a five-point satisfaction scale (1 = very dissatisfied, 5 = very satisfied): "How satisfied are you with your current work?", "How satisfied are you with the quality of the work you carry out?", "How satisfied are you with the amount of work you get done?", and "How satisfied are

you with your ability to solve problems that arise at work?" (QPS Nordic; [33–35]). The first item refers to satisfaction with the job as a whole; the remaining three concern satisfaction with aspects of one's own work accomplishment (the quality and amount of work done and the ability to solve problems at work) and therefore carry mastery-related content (see Section 5.3). All four items use the same satisfaction response format. A general life-satisfaction item fielded in the same block was not used (Table S6); a measurement model with this alternative item set is compared in Table S2. Internal consistency was satisfactory (Cronbach's alpha = 0.75).

3.2.5. Procedural Compliance (T4)

Procedural compliance was measured with a single dichotomous item [36]: "I always follow the procedures at my workplace" (recoded 0 = no, 1 = yes). In the analytic sample, 76% of respondents with observed data on this item reported compliance. Across the T3–T4 interval, the item showed $\varphi = 0.41$ with 78% raw agreement (see the notes to Table S4).

3.2.6. Control Variables

Age (open response), gender (recoded 0 = man, 1 = woman), and education level (1 = primary school to 5 = university/college 4 years or more) were included as covariates of T4 compliance in all models. Because respondents contributed to different waves, age and gender were taken from the most recent available wave (T4, with earlier waves used where T4 was missing), and education from T4 or, where missing, T3; the education response category "other" was set to missing.

3.3. Statistical Procedures

Analyses were conducted in R 4.5.1 using lavaan 0.6–21 [37], mice 3.19.0 [38], and lavaan.mi 0.1.1. Because the scale indicators were ordinal and the outcome was a single dichotomous item, the confirmatory factor and structural models treated the indicators as ordered-categorical and were estimated with diagonally weighted least squares with mean- and variance-adjusted test statistics (WLSMV; delta parameterisation), which models the binary outcome through a probit link rather than treating it as continuous [39].

We first generated 100 imputed datasets at the item level using chained equations (predictive mean matching for numeric variables, including the ordinal item scores, and logistic regression for binary variables; 20 iterations). The imputation model contained the 18 scale items of the structural model (the seven transformational-leadership items at T1, the three coworker-support and three quantitative-demands items at T2, and the five job-satisfaction items administered at T3, including the general life-satisfaction item that is not part of the final scale), compliance at T4 and at T3, age, gender, education, weekly working hours, and three auxiliary composites from adjacent waves (coworker support and quantitative job demands measured at T1 and job satisfaction measured at T2); every variable served as a predictor of every other variable. Respondents who participated in only one wave were retained because the imputation draws on all of their observed responses (although they contribute no directly observed cross-wave associations), whereas restricting the analysis to respondents observed in several waves would discard this information and condition the sample on the invitation pattern of the rotating panel. For respondents who entered the panel after T1, the T1 leadership items were accordingly imputed from their observed later responses, in particular the T2 coworker-support and job-demands items, the T2 job-satisfaction composite, the T3 job-satisfaction items, compliance at T3 and T4, and the demographic variables. Missing data were thus handled under a missing-at-random assumption, conditional on the variables included in the imputation model. The rotating invitation procedure accounts for part of the missingness by design, and four-wave completers did not differ from other T1 respondents on any T1 study variable (Table S1); nevertheless, the missing-at-random assumption cannot

be verified from the observed data, and the results depend on it. The fraction of missing information (FMI) of a parameter expresses the share of its sampling variance attributable to missing data; it is not the proportion of missing values. The FMI exceeded 0.50 for most structural parameters and was highest (0.88) for the direct path from T1 leadership to T4 compliance, the pair of variables with the smallest observed overlap (n = 463). With a maximum FMI of 0.88, m = 100 imputations yield an estimated relative efficiency above 99% [40,41]; the standard errors of the paths with high FMI are nevertheless correspondingly wide, and their estimates depend more strongly on the imputation model than those of paths with larger observed overlap. Imputation convergence was checked with trace and density diagnostics, and imputed distributions were compared with observed ones. Each model was estimated in every imputed dataset and results were pooled by Rubin's [42] rules. The current lavaan.mi implementation does not return pooled global fit indices for these categorical models; model fit is therefore summarised as the median and range of fit indices across the 100 imputed datasets, complemented by the fit of the corresponding observed-data models.

We then validated the measurement model before estimating the structural model. Convergent validity was evaluated with average variance extracted (AVE > 0.50) and composite reliability, reliability with Cronbach's alpha (>0.70), and discriminant validity with the heterotrait–monotrait ratio (HTMT < 0.85; [43]) and the Fornell–Larcker criterion ([44]; Table S3). Model fit was evaluated with CFI (>0.90; [45]), TLI (>0.90; [46]), RMSEA (<0.08; [45]), and SRMR (<0.09; [47]).

The constructs were measured in the hypothesised temporal sequence and specified accordingly in the structural model (T1–T4). Indirect and total effects were tested with Monte Carlo confidence intervals, which sample the path coefficients jointly from their pooled sampling distribution and accommodate the asymmetric distribution of product terms [48]; this approach is recommended when mediation models are combined with multiple imputation [49], and was used because nonparametric bootstrapping proved numerically unstable in combination with the categorical estimator and multiple imputation (see the notes to Table S4). Mediation analysis is used here as a framework for decomposing the time-lagged association between an earlier and a later variable into a direct component and indirect components transmitted through the intervening variables; because the variables were observed rather than manipulated, indirect effects are interpreted as temporally ordered associations that are consistent with, but do not demonstrate, a causal mechanism. Whether coworker support and job demands were also directly associated with compliance was examined by re-estimating the model with direct paths from these two variables to compliance; these additional paths are reported with pooled confidence intervals, and the indirect effects were re-estimated in this specification. A non-significant direct path is not interpreted as evidence that a direct association is absent.

Finally, we examined robustness in four ways (Table S4): re-estimation on the four-wave completers; re-estimation on all available observed data without imputation; a model additionally controlling compliance measured at T3, estimated within the same multiple-imputation framework and presented next to the primary model in Table 5; and re-estimation with an alternative job-satisfaction item set (see Table S2). A specification that additionally controlled the preceding-wave level of every construct produced a statistically inadmissible solution and its coefficients are therefore not interpreted (see the notes to Table S4).

4. Results

4.1. Reliability and Validity

Table 1 presents the demographic characteristics of the analytic sample, and Table 2 the descriptive statistics and correlations among the study variables. Most respondents with observed data on the outcome reported procedural compliance (1150 "yes", 75.9%; 366 "no", 24.1%).

Table 2. Descriptive statistics and correlations among the study variables (all available observed data).

Variable	M	SD	1	2	3	4	5	6	7
1. Transformational leadership (T1)	3.49	1.01	—						
2. Coworker support (T2)	4.00	0.78	0.44 ***	—					
3. Quantitative job demands (T2)	3.20	0.75	−0.12 **	−0.11 ***	—				
4. Job satisfaction (T3)	4.05	0.62	0.30 ***	0.31 ***	−0.18 ***	—			
5. Procedural compliance (T4)	0.76	0.43	0.17 ***	0.09 *	−0.09 *	0.15 ***	—		
6. Age	44.92	13.48	−0.05	−0.03	−0.15 ***	0.16 ***	0.07 **	—	
7. Female	0.49	0.50	0.03	0.01	0.14 ***	−0.06 *	0.12 ***	−0.06 ***	—
8. Education	3.79	1.12	0.10 **	0.08 *	0.23 ***	−0.02	−0.03	0.02	0.10 ***

Note: Correlations use all available observed pairs; pairwise sample sizes are reported in Table S5. Female: 1 = woman. For procedural compliance (1 = yes), M is the proportion reporting compliance. * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

The measurement model was estimated with WLSMV on all available observed data from the 3056 respondents who participated in at least one of T1–T3 and therefore had observed scores on at least one construct (the 557 respondents who entered the panel at T4 contributed no indicator data). Because the constructs were measured at three different waves (leadership at T1, coworker support and job demands at T2, job satisfaction at T3), no single sample size applies to all estimates: the polychoric correlations between items of constructs from different waves, and hence the cross-wave factor correlations, the Fornell–Larcker comparison, and the HTMT ratios, rest on the respondents observed in both waves concerned (n = 695 for leadership with coworker support or job demands, 548 for leadership with job satisfaction, and 736 for coworker support or job demands with job satisfaction; the two T2 constructs share the 1526 T2 respondents; Table S5), whereas the loadings, reliability, and AVE of each construct rest on the respondents observed at its wave (1511, 1526, or 1530). The HTMT ratios were computed from the same pairwise polychoric item correlations (semTools package). The model showed favourable approximate fit according to the CFI, TLI, RMSEA, and SRMR (CFI = 0.991, TLI = 0.989, RMSEA = 0.044, 90% CI [0.042, 0.047], SRMR = 0.059), although the χ^2/df ratio was elevated ($\chi^2(113) = 793.53$, $\chi^2/df = 7.02$); because this ratio is based on a test of exact fit and is highly sensitive to sample size, it was interpreted alongside the other indices. All standardised loadings were significant, ranging from 0.64 to 0.96 (Table 3). Convergent validity and reliability were supported for all constructs (AVE = 0.55 to 0.80; composite reliability = 0.81 to 0.97; Cronbach's alpha = 0.75 to 0.95). Discriminant validity was supported: the highest heterotrait–monotrait ratio was 0.53, well below the 0.85 criterion [43], and the Fornell–Larcker criterion was met for every pair of constructs (Table S3). An alternative job-satisfaction item set, in which the problem-solving item was replaced by the general life-satisfaction item, showed similar measurement properties when both sets were estimated with WLSMV on the four-wave completers (n = 312; AVE = 0.60 vs. 0.61; alpha = 0.78 vs. 0.80; Table S2), and re-estimating the structural model with this set on the multiply imputed data (N = 3613) left the sign and significance of all hypothesised paths unchanged (Table S4).

Table 3. Measurement model: standardised loadings, reliability, and convergent validity.

Construct	Items	Standardized Loadings	Cronbach's α	CR	AVE
Transformational leadership (T1)	7	0.83–0.94	0.95	0.97	0.80
Coworker support (T2)	3	0.76–0.92	0.80	0.87	0.68
Quantitative job demands (T2)	3	0.64–0.96	0.75	0.81	0.59
Job satisfaction (T3)	4	0.71–0.78	0.75	0.83	0.55

Note: Confirmatory factor analysis with WLSMV on all available observed data (n = 3056); all loadings significant at $p < 0.001$. CR = composite reliability; AVE = average variance extracted.

4.2. Hypotheses Testing

The hypothesised structural model was estimated on the multiply imputed data (m = 100) with WLSMV. Fit indices were favourable across the imputed datasets (CFI median 0.982, range 0.977–0.998; TLI median 0.985; RMSEA median 0.066, range 0.058–0.075; SRMR median 0.056), although the χ^2/df ratio was elevated (median 16.7, range 13.2–21.3); because this ratio is based on a test of exact fit and is highly sensitive to sample size, it was interpreted alongside the CFI, TLI, RMSEA, and SRMR. Of the 100 estimated solutions, 95 were admissible, and excluding the five inadmissible solutions did not materially alter the results (Table S4). The corresponding observed-data model provided complementary evidence of favourable approximate fit ($\chi^2(180) = 793.74$, $\chi^2/df = 4.41$, CFI = 0.981, RMSEA = 0.039, 90% CI [0.036, 0.042]). Table 4 (Panel A) reports all structural paths.

Transformational leadership at T1 was positively associated with coworker support (β = 0.45, 95% CI [0.40, 0.51]) and negatively with quantitative job demands at T2 (β = −0.15, 95% CI [−0.22, −0.08]), supporting Hypotheses 2 and 3. Job satisfaction at T3 was positively associated with transformational leadership (β = 0.09, 95% CI [0.01, 0.17]) and coworker support (β = 0.32, 95% CI [0.25, 0.40]) and negatively with job demands (β = −0.14, 95% CI [−0.21, −0.07]), supporting Hypotheses 4, 5, and 6. Job satisfaction was in turn positively associated with procedural compliance at T4 (β = 0.17, 95% CI [0.08, 0.26]), supporting Hypothesis 7, and transformational leadership remained positively associated with compliance (β = 0.12, 95% CI [0.04, 0.21]), supporting Hypothesis 1. Among the control variables, older age (β = 0.13, 95% CI [0.05, 0.20]) and female gender (β = 0.18, 95% CI [0.10, 0.25]) were positively associated with compliance, whereas education was not significantly associated with compliance (β = −0.06, 95% CI [−0.14, 0.02]). The model explained 21% of the variance in coworker support, 2% in job demands, 17% in job satisfaction, and 11% of the latent-response variance in compliance.

Table 4. Structural model results: direct paths, indirect and total effects, and additional direct paths (multiple-imputation main analysis, N = 3613).

Panel A. Structural Paths (Standardized β, Rubin-Pooled 95% CI)			
Path	**β**	**95% CI**	***p***
Transformational leadership (T1) → Coworker support (T2)	0.45	[0.40, 0.51]	<0.001
Transformational leadership (T1) → Job demands (T2)	−0.15	[−0.22, −0.08]	<0.001
Transformational leadership (T1) → Job satisfaction (T3)	0.09	[0.01, 0.17]	0.022
Coworker support (T2) → Job satisfaction (T3)	0.32	[0.25, 0.40]	<0.001
Job demands (T2) → Job satisfaction (T3)	−0.14	[−0.21, −0.07]	<0.001
Transformational leadership (T1) → Compliance (T4)	0.12	[0.04, 0.21]	0.004
Job satisfaction (T3) → Compliance (T4)	0.17	[0.08, 0.26]	<0.001
Age → Compliance (T4)	0.13	[0.05, 0.20]	0.002
Female → Compliance (T4)	0.18	[0.10, 0.25]	<0.001
Education → Compliance (T4)	−0.06	[−0.14, 0.02]	0.118
Panel B. Indirect and total effects (unstandardized probit estimates b, Monte Carlo 95% CI)			
Effect	**b**	**95% MC CI**	
Transformational leadership → Coworker support → Satisfaction	0.161	[0.107, 0.219]	
Transformational leadership → Job demands → Satisfaction	0.023	[0.009, 0.039]	
Transformational leadership → Coworker support → Satisfaction → Compliance	0.026	[0.009, 0.049]	
Transformational leadership → Job demands → Satisfaction → Compliance [a]	0.004	[0.001, 0.008]	
Leadership → Satisfaction → Compliance	0.016	[−0.004, 0.041]	
Coworker support → Satisfaction → Compliance	0.051	[0.018, 0.091]	
Job demands → Satisfaction → Compliance	−0.024	[−0.047, −0.007]	
Total indirect: Leadership → Compliance	0.046	[0.016, 0.082]	
Total effect: Leadership → Compliance	0.172	[0.050, 0.295]	

Table 4. *Cont.*

Panel C. Additional direct paths to compliance (unstandardized probit estimates b, Rubin-pooled 95% CI)			
Path	**b**	**95% CI**	***p***
Coworker support (T2) → Compliance (T4)	−0.044	[−0.143, 0.056]	0.388
Job demands (T2) → Compliance (T4)	−0.054	[−0.147, 0.038]	0.244

Note: Multiple imputation (m = 100), WLSMV/probit estimation, pooled by Rubin's rules (N = 3613). Panel A: standardized coefficients with Rubin-pooled 95% confidence intervals. Panel B: unstandardized probit estimates with Monte Carlo 95% confidence intervals (100,000 joint draws); an effect is significant when its interval excludes zero. Panel C: direct paths from coworker support and job demands to compliance added to the hypothesised model. [a] The symmetric delta-method interval for this very small effect narrowly included zero (see the notes to Table S4).

4.3. Test of Indirect Effects

Table 4 (Panel B) reports the indirect and total effects as unstandardized probit estimates (b) with Monte Carlo 95% confidence intervals. Consistent with Hypothesis 8, the indirect associations through job satisfaction were significant for coworker support (b = 0.051, 95% CI [0.018, 0.091]) and for quantitative job demands (b = −0.024, 95% CI [−0.047, −0.007]). For transformational leadership, the total indirect effect on compliance was significant (b = 0.046, 95% CI [0.016, 0.082]): the pathway through coworker support and job satisfaction was significant (b = 0.026, 95% CI [0.009, 0.049]), the pathway through job demands and job satisfaction was significant but very small (b = 0.004, 95% CI [0.001, 0.008]), and the pathway through job satisfaction alone was not significant (b = 0.016, 95% CI [−0.004, 0.041]). Hypothesis 8 was therefore partially supported.

To examine whether coworker support and job demands were also directly associated with compliance, the model was re-estimated with direct paths from these two variables to compliance (Table 4, Panel C). Neither additional path was significant (coworker support: b = −0.044, 95% CI [−0.143, 0.056]; job demands: b = −0.054, 95% CI [−0.147, 0.038]), and the indirect associations through job satisfaction remained significant in this specification (coworker support: b = 0.053, 95% MC CI [0.018, 0.097]; job demands: b = −0.025, 95% MC CI [−0.047, −0.007]). A non-significant direct path does not establish that a direct association is absent; these results indicate only that, beyond the indirect pathway through job satisfaction, no additional direct association of coworker support or job demands with later compliance was detected. In the primary model, both the direct path from transformational leadership to compliance and its total indirect association were significant.

4.4. Robustness

The pattern of results was consistent across samples, estimators, and missing-data treatments (Table S4), with two informative exceptions. In the complete-case sample of four-wave completers (n = 311), the association between transformational leadership and job satisfaction was not significant (β = 0.11, $p = 0.120$). The second exception concerns the model that additionally controls for compliance measured at T3. This model addresses a different question, namely the association with T4 compliance beyond its earlier level, and is presented next to the primary model in Table 5. It was estimated in the same multiple-imputation framework as the primary model (N = 3613), with T3 compliance included in the imputation model, so that the two models in Table 5 differ only in the added covariate. Compliance at T3 was strongly associated with compliance at T4 (β = 0.43, $p < 0.001$). After this adjustment, job satisfaction remained positively associated with compliance (β = 0.12, 95% CI [0.03, 0.20], $p = 0.007$), whereas the direct association between transformational leadership and compliance was smaller than in the primary model and not statistically significant (β = 0.07, 95% CI [−0.004, 0.151], $p = 0.063$). The indirect associations through job satisfaction remained significant for coworker support (b = 0.038, 95% MC CI [0.005, 0.077])

and for job demands (b = −0.017, 95% MC CI [−0.038, −0.002]), as did the total indirect association of leadership with compliance (b = 0.032, 95% MC CI [0.004, 0.069]), which included the significant pathway through coworker support and job satisfaction (b = 0.019, 95% MC CI [0.002, 0.040]); the total association of leadership with compliance in this model was not significant (b = 0.116, 95% MC CI [−0.018, 0.251]). The difference between the leadership coefficients of the two models was not tested statistically, and a non-significant coefficient does not demonstrate the absence of a direct association. An alternative job-satisfaction item set yielded substantively identical conclusions (Table S2).

Table 5. Direct paths and indirect and total effects in the primary model and in the model additionally controlling compliance at T3 (multiple-imputation analyses, N = 3613).

	Primary Model		**Prior-Compliance-Adjusted Model**	
Panel A. Structural paths (standardised β, Rubin-pooled 95% CI)				
Path	β [95% CI]	*p*	β [95% CI]	*p*
Transformational leadership (T1) → Coworker support (T2)	0.45 [0.40, 0.51]	<0.001	0.45 [0.39, 0.50]	<0.001
Transformational leadership (T1) → Job demands (T2)	−0.15 [−0.22, −0.08]	<0.001	−0.14 [−0.20, −0.08]	<0.001
Transformational leadership (T1) → Job satisfaction (T3)	0.09 [0.01, 0.17]	0.022	0.08 [0.01, 0.16]	0.028
Coworker support (T2) → Job satisfaction (T3)	0.32 [0.25, 0.40]	<0.001	0.32 [0.24, 0.39]	<0.001
Job demands (T2) → Job satisfaction (T3)	−0.14 [−0.21, −0.07]	<0.001	−0.13 [−0.20, −0.06]	<0.001
Transformational leadership (T1) → Compliance (T4)	0.12 [0.04, 0.21]	0.004	0.07 [−0.004, 0.151]	0.063
Job satisfaction (T3) → Compliance (T4)	0.17 [0.08, 0.26]	<0.001	0.12 [0.03, 0.20]	0.007
Compliance (T3) → Compliance (T4)	—		0.43 [0.38, 0.49]	<0.001
Age → Compliance (T4)	0.13 [0.05, 0.20]	0.002	0.09 [0.02, 0.17]	0.016
Female → Compliance (T4)	0.18 [0.10, 0.25]	<0.001	0.12 [0.05, 0.20]	0.001
Education → Compliance (T4)	−0.06 [−0.14, 0.02]	0.118	−0.03 [−0.10, 0.05]	0.473
Panel B. Indirect and total effects (unstandardized probit estimates b, Monte Carlo 95% CI)				
Effect	b [95% MC CI]		b [95% MC CI]	
Transformational leadership → Coworker support → Satisfaction	0.161 [0.107, 0.219]		0.153 [0.101, 0.211]	
Transformational leadership → Job demands → Satisfaction	0.023 [0.009, 0.039]		0.020 [0.007, 0.036]	
Transformational leadership → Coworker support → Satisfaction → Compliance	0.026 [0.009, 0.049]		0.019 [0.002, 0.040]	
Transformational leadership → Job demands → Satisfaction → Compliance	0.004 [0.001, 0.008]		0.002 [0.0002, 0.006]	
Transformational leadership → Satisfaction → Compliance	0.016 [−0.004, 0.041]		0.011 [−0.004, 0.034]	
Coworker support → Satisfaction → Compliance	0.051 [0.018, 0.091]		0.038 [0.005, 0.077]	
Job demands → Satisfaction → Compliance	−0.024 [−0.047, −0.007]		−0.017 [−0.038, −0.002]	
Total indirect: Transformational leadership → Compliance	0.046 [0.016, 0.082]		0.032 [0.004, 0.069]	
Total effect: Transformational leadership → Compliance	0.172 [0.050, 0.295]		0.116 [−0.018, 0.251]	

Note: Both models: multiple imputation (m = 100), WLSMV/probit estimation, N = 3613; the adjusted model adds compliance at T3 as a covariate of compliance at T4. Panel A: standardized coefficients with Rubin-pooled 95% confidence intervals. Panel B: unstandardized probit estimates with Monte Carlo 95% confidence intervals (100,000 joint draws). Fit and admissibility of the adjusted model are reported in Table S4.

5. Discussion

The present study examined time-lagged associations between transformational leadership, quantitative job demands, coworker support, job satisfaction, and general procedural compliance. Drawing on transformational leadership theory and the Job Demands–Resources (JD–R) model, we investigated a temporally ordered model linking transformational leadership at T1 with quantitative job demands and coworker support at T2, job satisfaction at T3, and self-reported general procedural compliance at T4. By positioning general procedural compliance as the focal outcome and using the JD–R model

as an explanatory framework, the study extends previous research that has primarily examined safety-specific compliance or relied on cross-sectional associations.

The main findings were broadly supported across several robustness and sensitivity analyses, although the direct association between transformational leadership and compliance varied across specifications. In the multiple-imputation sensitivity analysis using the full analytic sample (N = 3613), job satisfaction at T3 remained positively associated with procedural compliance at T4 after adjustment for compliance at T3 (β = 0.12, p = 0.007). The direct association between transformational leadership at T1 and compliance at T4 was smaller than in the primary model and was not statistically significant (β = 0.07, p = 0.063). These findings strengthen the evidence for an association between job satisfaction and subsequent compliance conditional on prior compliance, while qualifying the robustness of the direct leadership–compliance association. Although adverse occupational outcomes were not measured, procedural compliance may be relevant to occupational public health because workplace procedures can include practices intended to reduce risk and prevent undesirable outcomes.

This research contributes to safety and organisational research in two main ways. First, previous research on psychosocial work factors and safety has relied heavily on cross-sectional designs [22]. By separating the focal constructs across four waves collected over two years, the present study provides evidence of temporally ordered associations, although it does not establish causality or within-person change. Second, the heterogeneous sample of Norwegian employees extends the empirical context of compliance research beyond individual high-risk industries, although generalizability to particular occupations and industries requires further examination.

5.1. Theoretical Contributions

This study contributes to compliance research by positioning general procedural compliance within the JD–R framework and examining its time-lagged associations with transformational leadership, coworker support, quantitative job demands, and job satisfaction. Previous research has emphasised the relevance of leadership and organisational practices to safety compliance [50]. Extending this perspective, the present findings indicate that self-reported general procedural compliance is associated with leadership and psychosocial work factors measured at earlier waves. A further contribution is the simultaneous examination of leadership, psychosocial work factors, and job satisfaction in relation to general procedural compliance. Transformational leadership and job satisfaction remained positively associated with compliance after adjustment for age, gender, and education, while coworker support and quantitative job demands showed indirect associations through job satisfaction. This pattern supports examining leadership and psychosocial work conditions together when seeking to understand procedural compliance. A further theoretical contribution concerns the relevance of general rather than safety-specific transformational leadership to procedural compliance. Previous research has questioned a strict distinction between general and safety-specific transformational leadership [14]. Extending this work, transformational leadership at T1 was directly associated with general procedural compliance at T4 and showed a significant total indirect association. The serial indirect association through coworker support and job satisfaction was significant, while the serial indirect association through quantitative job demands and job satisfaction was significant according to the Monte Carlo interval, but very small. The indirect association between transformational leadership and general procedural compliance through job satisfaction alone, without coworker support or quantitative job demands, was not significant. In the primary model, transformational leadership showed both a significant direct association and a significant total indirect association with compliance. After controlling for T3 com-

pliance, the total indirect association remained significant, whereas the direct association was not statistically significant. The study further contributes to theory by clarifying the role of coworker support in the proposed model. Coworker support at T2 was positively associated with job satisfaction at T3, supporting Hypothesis 5, while job satisfaction was positively associated with general procedural compliance at T4, supporting Hypothesis 7. The indirect association between coworker support and compliance through job satisfaction was significant. When the direct path from coworker support to compliance was added, it was not statistically significant, whereas the indirect effect through job satisfaction remained significant. These findings support the proposed mediating role of job satisfaction in the time-lagged association between coworker support and later procedural compliance.

A similar pattern was observed for quantitative job demands. Quantitative job demands at T2 were negatively associated with job satisfaction at T3, supporting Hypothesis 6, and showed a significant negative indirect association with compliance through job satisfaction. The additional direct path from quantitative job demands to compliance was not statistically significant, whereas the indirect effect through job satisfaction remained significant. These findings support the proposed mediating role of job satisfaction in the association between quantitative job demands and later procedural compliance.

Overall, Hypothesis 8 received partial support in the primary model. Coworker support and quantitative job demands showed significant indirect associations with general procedural compliance through job satisfaction. The serial indirect association between transformational leadership and compliance through coworker support and job satisfaction was also significant. The corresponding serial indirect association through quantitative job demands and job satisfaction was very small and sensitive to the method used to estimate its confidence interval, while the indirect association between transformational leadership and compliance through job satisfaction alone was not significant. Thus, the results support several, but not all, of the indirect associations proposed in Hypothesis 8.

Taken together, the study advances compliance research by testing a time-lagged serial mediation model linking transformational leadership, coworker support, quantitative job demands, job satisfaction, and general procedural compliance. The four-wave design, with successive time lags of six, six, and twelve months, provides evidence concerning the temporal ordering of these associations. The findings distinguish between direct and indirect associations in the proposed model but do not establish causality or within-person change.

5.2. Practical Implications

The findings suggest that organisations seeking to understand general procedural compliance should consider leadership and psychosocial work conditions alongside formal rules and procedures. Transformational leadership and job satisfaction were positively associated with later compliance, while coworker support and quantitative job demands showed indirect associations through job satisfaction. This pattern supports a systems-oriented perspective in which procedural compliance is considered in relation to the broader organisational and psychosocial work environment.

Transformational leadership was positively associated with subsequent coworker support and negatively associated with quantitative job demands. Transformational leadership and coworker support were positively associated with later job satisfaction, whereas quantitative job demands were negatively associated with job satisfaction. In the primary model, both transformational leadership and job satisfaction were positively associated with later procedural compliance, and several indirect associations supported the proposed mediation framework. In the full-sample multiple-imputation sensitivity analysis controlling for prior compliance, the job satisfaction–compliance association remained statistically significant, whereas the direct leadership–compliance association did not. Thus, the findings support

the relevance of job satisfaction to subsequent self-reported procedural compliance, including after adjustment for its prior level, while the direct association with transformational leadership was less robust. The findings do not establish causality or within-person change. Because accidents and injuries were not measured, accident prevention remains a potential implication rather than a demonstrated outcome.

The results also suggest that compliance initiatives may benefit from considering quantitative job demands, coworker support, and job satisfaction together rather than as isolated factors. Organisations could monitor whether workloads are manageable, whether employees experience adequate support from coworkers, and how these conditions are associated with job satisfaction. The significant indirect associations through job satisfaction suggest that employee satisfaction is relevant when considering how coworker support and quantitative job demands relate to procedural compliance. These practical implications concern general procedural compliance rather than safety-specific outcomes.

5.3. Limitations and Future Research

The findings should be interpreted in light of several limitations and corresponding strengths. First, the heterogeneous sample broadens the empirical context beyond individual industries, but it does not ensure generalizability to particular occupations, sectors, or countries. Moreover, the rotating panel resulted in substantial missingness across waves. Multiple imputation made it possible to include all 3613 participants who responded to at least one wave, and the general pattern of findings was generally consistent across the complete-case and observed-data analyses. Nevertheless, the imputed results depend on the missing-at-random assumption. With 2166 respondents participating in only one wave and a maximum fraction of missing information of 0.88, several estimates depended substantially on the imputation model, which should be considered when assessing their precision and robustness. Replication in well-defined occupational and industry samples is therefore warranted.

Second, separating the focal constructs across four waves strengthens the examination of their theoretically proposed temporal ordering compared with a cross-sectional design. However, it does not establish causality or within-person change. Several focal constructs were also measured at other waves (coworker support and job demands at T1, job satisfaction at T2, and compliance at T3), and these measures served as auxiliary variables in the imputation model and in the preceding-wave specification; however, each construct entered the focal model at a single prespecified wave to preserve the temporal ordering, and the specification controlling the preceding-wave level of every construct did not yield an admissible solution (Table S4). Earlier levels and reciprocal associations could therefore not be controlled systematically. In the sensitivity analysis controlling for compliance at T3 (Table 5), the association between job satisfaction at T3 and compliance at T4 remained statistically significant, whereas the direct association between transformational leadership at T1 and compliance at T4 was smaller and not statistically significant, although the indirect association of leadership with compliance through coworker support and job satisfaction remained significant. This result warrants some caution when interpreting the direct association between transformational leadership and later compliance. Future studies could measure all constructs at multiple waves and apply models that distinguish stable between-person differences from within-person dynamics, such as the RI-CLPM [51].

Third, procedural compliance was measured using a single self-reported dichotomous item based on an earlier indicator [36], with “at my workplace” added to specify the context. The original indicator was positively associated with safety climate and negatively associated with procedure vagueness, as theoretically expected, providing evidence consistent with nomological validity [36]. In the robustness analysis controlling for T3

compliance (Table 5), compliance at T3 was positively associated with compliance at T4, and job satisfaction remained positively associated with T4 compliance after controlling for T3 compliance. Nevertheless, a single yes/no item provides limited information about the extent of compliance and does not allow assessment of internal consistency. Future studies could use a Likert-type response scale to capture more variation and compare the item with multi-item measures and independent assessments of compliance.

The job-satisfaction measure combined overall satisfaction with current work and satisfaction with aspects of work accomplishment. The mastery-related content may limit its comparability with conventional job-satisfaction scales. Although the alternative item set yielded similar results, it retained some of this content and therefore did not fully resolve this measurement issue.

Finally, examining general rather than safety-specific transformational leadership and compliance enabled the study to include employees across diverse work settings. At the same time, this choice limits conclusions about safety-specific processes in high-risk settings, and accidents and injuries were not measured. Replication using both general and safety-specific measures could clarify their relative contributions. Experimental, quasi-experimental, and intervention studies could further examine whether changes in leadership practices or psychosocial work conditions are followed by changes in procedural compliance.

6. Conclusions

This four-wave study examined time-lagged associations between transformational leadership, coworker support, quantitative job demands, job satisfaction, and self-reported general procedural compliance. Integrating transformational leadership theory with the JD–R model, the study used data collected over two years from 3613 Norwegian employees who participated in at least one wave. By focusing on general rather than safety-specific procedural compliance, the study extends the empirical context of compliance research across diverse work settings.

Transformational leadership was positively associated with subsequent coworker support and negatively associated with quantitative job demands. Transformational leadership and coworker support were positively associated with later job satisfaction, whereas quantitative job demands were negatively associated with it. In the primary model, both transformational leadership and job satisfaction were positively associated with later procedural compliance. Coworker support and quantitative job demands showed significant indirect associations with compliance through job satisfaction, whereas their additional direct paths were not statistically significant. After controlling for T3 compliance, job satisfaction remained positively associated with T4 compliance, and the total indirect association between transformational leadership and compliance remained significant. Neither the direct nor the total association between transformational leadership and compliance was statistically significant in this specification. These findings support the proposed mediating role of job satisfaction in several of the examined associations with later self-reported general procedural compliance. The temporally ordered associations do not establish causality or within-person change. Because accidents and injuries were not measured, accident prevention remains a potential implication rather than a demonstrated outcome.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/ijerph23111346/s1. Figure S1: Participant flow across the four survey waves. Table S1: Attrition analysis: four-wave completers versus non-completers among T1 respondents. Table S2: Measurement models: alternative specifications and the final model. Table S3: Discriminant validity of the final measurement model. Table S4: Robustness of the structural paths across samples and specifications. Table S5: Pairwise sample sizes underlying the correlations in Table 2. Table S6: Retained, excluded, and unused items per construct.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki. Before data collection began in September 2021, the LeadWork research team reviewed the applicable data-protection notification requirements (https://NSD.no (accessed on 21 April 2021)), now administered by Sikt—the Norwegian Agency for Shared Services in Education and Research. The project was assessed as not requiring notification for data-protection review because the researchers had no access to directly or indirectly identifiable personal data. Norstat retained all identifying information. The project complied with applicable Norwegian data-protection requirements. Institutional ethical approval was subsequently obtained from the University of Stavanger Business School and Law Review Board on 9 September 2025 (protocol code HHUiS-IRB-2025-003).

Informed Consent Statement: Informed and active consent was obtained from all subjects involved in the study.

Data Availability Statement: The data are not publicly available because they form part of an ongoing longitudinal panel study. Requests for access may be directed to the corresponding author and will be considered subject to applicable ethical and data-protection requirements.

Conflicts of Interest: The authors declare no conflicts of interest.

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