



## Article

# The Impact of Contextual Constraints on the Role of Management Commitment in Safety Culture: A Moderation Analysis

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**Abstract:** Safety culture (SC) can play a key role in workers' health and well-being, as well as in organizational performance. The literature has demonstrated a positive relationship between SC and organizational indicators such as safety performance. However, there is still a need to understand the impact of contextual factors and to identify strategies that promote employee well-being and organizational effectiveness. This cross-sectional study aims to analyze the relationship between different components of SC—management commitment, safety management systems (SMS), and worker participation in safety—and to explore the moderating role of perceived barriers to the use of personal protective equipment (PPE) and the physical demands of the job in these relationships. The study involved 473 Portuguese workers from the construction and industrial sectors. Correlation and moderation analyses were performed. The results revealed positive correlations among the main SC components, highlighting their interconnection within the organizational context. A moderating effect—albeit of small magnitude—was also found for both perceived barriers and physical demands in the relationship between management commitment and the other dimensions of SC. The results are discussed in light of their implications for safety management and the promotion of healthier and more sustainable workplaces.



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**Keywords:** safety culture; management commitment; perceived barriers to PPE use; physical job demands

## 1. Introduction

Workplace safety remains one of the most pressing challenges of our time, with significant impacts not only on occupational health but also on public health and organizational sustainability [1–3]. According to recent estimates, more than 2.9 million people die annually due to work-related accidents and illnesses, while over 400 million workers suffer non-fatal injuries each year [4–6]. Beyond the human toll, the direct and indirect economic costs associated with poor working conditions represent approximately 5.4% of the global GDP [2,6].

In Portugal, the most recent data reveal an alarming situation: in 2024 alone, 312 serious work accidents and 131 fatal accidents were reported, with the construction and manufacturing sectors being the most affected [7–9]. At the European level, in 2022, approximately 2.97 million non-fatal work accidents and 3286 fatal accidents were recorded, with construction and industry again standing out as the sectors with the highest prevalence of

fatalities [4,10,11]. These sectors, characterized by complex and high-risk environments, continue to be the most exposed to severe accidents [12–15].

In addition to the direct impact on workers' physical and psychological health, work accidents have broad social and economic consequences: loss of income, increased medical expenses, strain on healthcare and social security systems, organizational disruptions, and productivity losses, ultimately compromising workers' performance [1–3]. Other costs also emerge, such as changes in workers' family and social dynamics, shifts in organizational climate, and erosion of collective trust (i.e., emotional bonds with colleagues and immediate supervisors) [1].

This scenario reinforces the need to strengthen the link between occupational safety, health, and organizational sustainability. The United Nations' 2030 Agenda, by including occupational safety and health in the Sustainable Development Goals (SDG 3—Good Health and Well-Being; SDG 8—Decent Work and Economic Growth), highlights the need to promote safe and healthy workplaces as a foundation for sustainable, equitable, and resilient development [2,3]. However, despite progress in regulation, training, and technical interventions, significant weaknesses remain in organizational safety practices and behaviors [1,2,16]. In this context, the concept of safety culture gains particular relevance, understood as a shared set of values, perceptions, and practices that guide how risks are managed within organizations [1,17,18]. Empirical evidence has shown that a strong safety culture is associated with better safety performance outcomes, as well as higher levels of job satisfaction, motivation, and workplace well-being [12,19–22].

It is precisely from this concern with safety issues and the well-being of workers and organizations that the present study emerges. More specifically, drawing on the results of a PhD project on occupational safety [21], this study aims to deepen the understanding of the dynamics that shape safety culture, with particular focus on the role of management commitment as a central variable that enhances other fundamental dimensions, such as the implementation of safety management systems (SMS) and worker participation in safety [1,18,23–26].

Additionally, the study seeks to analyze how two contextual factors—perceived barriers to the use of personal protective equipment (PPE) and physical job demands—may moderate the relationships between management commitment and other components of safety culture. The inclusion of these variables aims to explore how practical and physical constraints in the work context can either hinder or strengthen the influence of management on organizational safety [15,27,28]. This integrative perspective not only offers a better understanding of the mechanisms underlying safety performance but also contributes to the development of more effective and sustainable evidence-based organizational strategies.

## 2. Literature Review

### 2.1. Safety Culture: Concept and Core Components

The concept of safety culture (SC) has gained a central role in the field of occupational health and safety (OHS), as it highlights that risky behaviors and workplace accidents are not solely the result of technical failures or individual decisions but are also expressions of deeply rooted cultural patterns within organizations [1,2,16–18]. This approach marks a significant shift, moving away from a purely normative and prescriptive logic toward a systemic and integrated perspective, in which human, organizational, and technical factors interact to shape safe working environments [26,29,30].

SC can be defined as the shared set of values, attitudes, perceptions, norms, and practices that influence how members of an organization perceive and manage occupational risks [17–19]. It is a collective and dynamic phenomenon, reflected in organizational routines and in the way both workers and management interpret and respond to safety

challenges. A well-developed culture in this domain fosters safer work environments, strengthens organizational trust, and contributes to workers' physical and psychological well-being [15,20].

The literature has identified three key dimensions of SC that serve as operational pillars of this organizational reality: management commitment to safety, SMS, and worker participation in safety [1,17,18,31]. The first dimension, management commitment, refers to the degree of involvement, visibility, and consistency demonstrated by management regarding safety issues. It encompasses attitudes, behaviors, and decisions that signal, in the eyes of workers, the priority the organization places on OHS [1,17,26,32]. This commitment is often considered the core of SC [17], as it directly influences the remaining dimensions and serves as a model for expected workplace behaviors.

The second dimension concerns SMS, which reflect the formalization of OHS principles and procedures into policies, practices, and control mechanisms. These systems include, among others, prevention plans, training programs, communication channels, emergency procedures, safety incentives, and auditing processes [17,23,25,33]. When effectively implemented, SMS ensure coherence between the organization's values and its daily operations, thereby reinforcing the existing SC.

The third dimension, worker participation, encompasses employees' behaviors and attitudes toward workplace safety [21]. It refers to the active involvement of employees in risk identification, incident reporting, proposing improvements, and voluntary engagement in safety initiatives [12,21,24]. This participation not only enriches the SC but also promotes a healthier organizational climate, enhancing workers' well-being and engagement in preventive practices [20,24].

These three dimensions do not operate alone; on the contrary, they function in an interdependent and systemic manner [17,21,23,26,29]. An effective SC requires the harmonious integration of these components in order to create an organizational environment in which prevention and workers' well-being are shared priorities embraced at all hierarchical levels [18,34]. It is precisely this logic of interdependence, with particular emphasis on the structuring role of management commitment, that will be further explored in the next section.

## *2.2. Management Commitment as an Expression of Organizational Support for Safety*

Among the various dimensions that structure SC, management commitment stands out as its central axis. Empirical evidence has shown that workers' perceptions of management involvement in safety issues directly influence their behaviors, attitudes, and level of adherence to safe practices [17,21,26,32,35–38]. This influence goes beyond individual behavioral aspects, extending to how the organization structures and operationalizes its SMS—leading to more efficient and developed systems—and how it engages workers in safety practices [17,21,23,32,39]. In this regard, management commitment can be considered a structuring factor of SC, with a transversal impact on the remaining dimensions [17,32,38,39].

Management commitment can be understood as the degree of involvement, visibility, and consistency demonstrated by management in promoting workplace safety [1,17,32]. It involves knowledge of OHS procedures, favorable attitudes toward safety, visible behaviors (such as workplace visits and direct communication with workers), as well as decisions that reflect the actual prioritization of safety over other organizational demands [17,18,32,39–41]. When this prioritization is perceived by workers as authentic, consistent, and sustained, it tends to strengthen organizational trust and foster a more active engagement in safety practices [26].

### 2.2.1. Management Commitment and the Implementation of SMS

Several empirical studies have demonstrated that management commitment is a key factor in the effective implementation of SMS [17,21,23,39,42–44]. At this level, the NP ISO 45001 (i.e., the Portuguese version of the international ISO 45001 standard, which defines the requirements for occupational health and safety management systems) also highlights management commitment as an essential prerequisite for the effectiveness of SMS [25]. It is the management that organizes, finances, and oversees the mechanisms that operationalize safety policies and procedures. The literature has shown that in contexts where management plays an active role aligned with the principles of SMS, the system's implementation is more effective and sustained, with a positive impact on the organization and on safety performance [17,32,43,45].

Conversely, the lack of management commitment is often identified as a critical barrier to SMS implementation, associated with the underestimation of risks, insufficient resource allocation, and the limited integration of OHS into organizational priorities [23]. Thus, management does not operate merely in a technical or administrative dimension, but also acts as a reflection of the importance placed on safety, ensuring coherence between institutional values and operational practices [17,32].

Beyond structuring and operationalizing SMS, management commitment also plays a decisive role in promoting the active participation of workers in safety practices.

### 2.2.2. Management Commitment and Worker Participation

The relationship between management commitment and worker participation in safety is also widely supported in the literature [17,21,24,32,39]. Managers who communicate openly, listen actively, and demonstrate genuine concern for workers' well-being help create the necessary conditions for an environment in which employees feel safe to report incidents, suggest improvements, and actively engage in preventive initiatives [26]. Workers' attitudes and behaviors toward safety are strongly influenced by their perception of how much value management places on safety, which significantly contributes to the adoption of safe practices in the workplace [17,32,35,37,38,46]. When workers perceive that their safety is genuinely valued by management, they are more likely to respond with greater commitment, adopting behaviors that reflect and reinforce the organization's strategic goals [21].

In sum, management commitment serves as a driving force behind SC, acting as a catalyst for both the formal structure (SMS) and the human and collective involvement (worker participation). Consistently, research has shown that management commitment is one of the most decisive factors in organizational safety performance and, as such, a key dimension in building safer, healthier, and more sustainable workplaces [21].

## 2.3. Critical Contextual Factors: Barriers to PPE Use and Physical Job Demands

In addition to the core dimensions of SC, there are contextual factors that significantly influence how this culture manifests in the daily life of organizations [15,18,24]. Among these factors, perceived barriers to the use of PPE and physical job demands stand out, as their effects may attenuate or constrain the influence of management in promoting safe behaviors [15,27,28,47]. Understanding these elements is essential for managing safety in a more realistic and effective way, especially in demanding work environments such as construction and industry.

### 2.3.1. Perceived Barriers to PPE Use

Perceived barriers to PPE use refer to the obstacles that hinder the consistent adoption of these protective tools by workers. These barriers are often related to issues such as

availability, convenience, physical discomfort, maintenance, ease of use, and the perceived savings in time and effort [3,28,40,48–52]. Several studies [3,27,28,50,53,54] have identified factors such as discomfort, excessive heat, the weight of the equipment, restricted mobility, and reduced visibility or hearing, as well as the perception that PPE interferes negatively with productivity. These barriers are particularly relevant in physically demanding tasks or high-intensity production settings, where workers may prioritize agility or immediate comfort over safety [27,28].

The perception of these barriers may be further aggravated by permissive or inconsistent organizational practices, where management fails to clearly and consistently reinforce the mandatory nature and importance of proper PPE use [6,27]. In such contexts, workers may interpret the use of protective equipment as optional or discretionary, especially when there are no mechanisms for supervision, positive reinforcement, or accountability [3,6,27,47]. Conversely, managers who value safety, communicate effectively, and promote a culture of responsible PPE use tend to significantly reduce workers' resistance [50,53].

### 2.3.2. Physical Job Demands

Physical job demands refer to the physical effort required to carry out work tasks, including, for example, lifting heavy loads, forced postures, repetitive movements, or prolonged exposure to harsh environments [18,38,55,56]. These demands not only increase the risk of musculoskeletal injuries, health problems, and absenteeism but also reduce productivity and work quality, negatively affecting workers' safety behaviors [15,24,57,58].

Physically demanding tasks, particularly those involving intense exertion, have been associated with negative effects on safety behaviors, as they deplete workers' physical and psychological resources and compromise their ability to consistently maintain safe practices [15,57]. When these practices also require additional effort, such as the use of PPE, they may be perceived as obstacles to efficient task execution [27,28]. In this context, organizational resources associated with management commitment and SMS become particularly important, potentially serving as compensatory factors for the physical demands of the job [15]. Through active listening, on-site monitoring, and the adoption of simple measures—such as choosing more ergonomic equipment or encouraging appropriate breaks—managers can reinforce their commitment to safety and facilitate adherence to preventive practices [59,60].

### 2.3.3. Justification for Their Analysis as Moderating Variables

The decision to include these variables as moderators in the relationship between the components of SC is based on the premise that, although management commitment has a cross-cutting impact on SC, this impact may be conditioned by physical and operational context factors. In other words, even highly committed managers may find their influence limited when workers face constraints that hinder the practical application of the desired safety behaviors [15,28].

By exploring the moderating role of perceived barriers and physical job demands, this study seeks to understand under which conditions management commitment may be more or less effective in promoting SMS and worker participation. This approach allows for a more realistic analysis of organizational dynamics [61] and contributes to the development of intervention strategies better suited to the operational realities of companies, namely, through the ergonomic improvement of equipment, the reduction of unnecessary physical demands [15,59,60], and the strengthening of communication between managers and workers concerning safety issues [24,60].

## 2.4. Research Objectives and Hypotheses

Based on the literature review presented above, the present study aims to analyze the influence of management commitment on two fundamental dimensions of SC: the implementation of SMS and worker participation in safety. In parallel, it seeks to understand the moderating role of two contextual factors—perceived barriers to PPE use and physical job demands—in the relationships among SC components. Below are the study's specific objectives and the corresponding hypotheses.

### 2.4.1. Specific Objective 1

To analyze the relationship between management commitment and the implementation of SMS, and the relationship between management commitment and worker participation in safety.

**H1a.** *Management commitment is positively related to the implementation of SMS.*

**H1b.** *Management commitment is positively related to worker participation in safety.*

### 2.4.2. Specific Objective 2

To analyze the moderating role of perceived barriers to PPE use and physical job demands in the relationship between management commitment and SMS implementation.

**H2a.** *Perceived barriers to PPE use moderate the relationship between management commitment and SMS implementation.*

**H2b.** *Physical job demands moderate the relationship between management commitment and SMS implementation.*

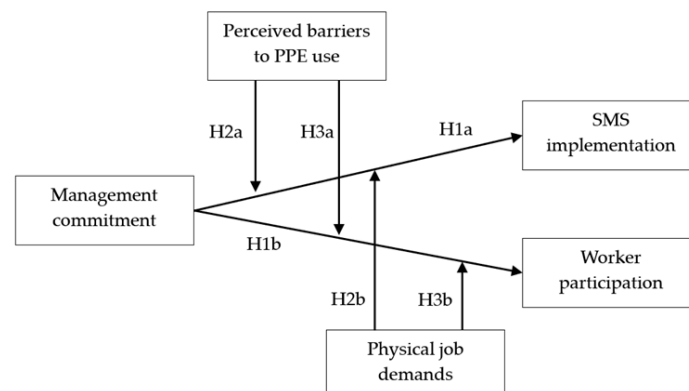
### 2.4.3. Specific Objective 3

To analyze the moderating role of perceived barriers to PPE use and physical job demands in the relationship between management commitment and worker participation.

**H3a.** *Perceived barriers to PPE use moderate the relationship between management commitment and worker participation in safety.*

**H3b.** *Physical job demands moderate the relationship between management commitment and worker participation in safety.*

Figure 1 presents the various hypotheses developed within the scope of the present study.



**Figure 1.** Conceptual representation of the hypotheses of the study.

### 3. Methods

This study is quantitative and cross-sectional in nature, and it was approved by the Ethics Committee for Research in Social and Human Sciences of the University of Minho (CEICSH 101/2020). Its main objective is to analyze the relationships between variables associated with safety culture in the workplace and to explore the moderating role of contextual factors. The methodology includes a description of the sample, the instruments used, data collection procedures, and the statistical analysis strategy.

#### 3.1. Sample

The sample consisted of 473 workers, of whom 352 were men (74.9%) and 118 were women (25.1%). Regarding age, 119 workers were aged up to 30 years (25.5%), 117 were between 31 and 40 years old (25.1%), 113 were between 41 and 50 years old (24.2%), 107 were between 51 and 60 years old (23%), and 10 workers were over 60 years old (2.2%). In terms of educational level, 195 workers (42.6%) had less than high school education, 201 (43.9%) had completed high school, and 62 (13.5%) had college education. A total of 268 participants (56.7%) worked in the industrial sector and 205 (43.3%) in construction. With regard to job tenure, 128 participants (28.6%) had been working in their profession for less than three years, 70 (15.6%) between three and six years, and 250 (55.8%) for more than six years. It is also worth noting that 11.8% of participants reported having had a work accident in the previous six months, and of these, the majority (63%) were unable to work as a result of the incident.

#### 3.2. Instruments

The research protocol used for data collection consisted, in the first part, of a sociodemographic, professional, and family questionnaire, aimed primarily at characterizing the sample.

In the second part, the protocol included a set of scales assessing various dimensions related to workers' safety, such as management behaviors, worker involvement in safety matters, and work pressure and overload. In total, the questionnaire comprised 85 items, evaluated using a five-point Likert scale, ranging from 1 "Strongly disagree" to 5 "Strongly agree". The various scales used, both in their original versions [17,33,38,62–64] and in versions adapted to the Portuguese context [65–67], demonstrated good psychometric properties, with Cronbach's alpha coefficients above 0.70.

For the purposes of this study, and based on the psychometric analysis of the questionnaire, the items were grouped into the following dimensions and subdimensions: management commitment (9 items divided into management attitudes and management behaviors), worker participation in safety (10 items divided into worker involvement, worker safety awareness, and coworker support), SMS (38 items divided into safety policies, incentives, training, communication, planning, reduced work pressure and overload, and internal control), perceived barriers to PPE use (5 items) and physical job demands (3 items).

#### 3.3. Procedures

Data collection was carried out in six companies located in the North of Portugal, three from the construction sector and three from the industrial sector. Initial contact was made with the organizations' Human Resources managers, during which the scope and objectives of the project were explained, as well as the potential benefits of participating. Once the most suitable data collection strategy was agreed upon with each organization, questionnaires were distributed to the workers. Most of the data were collected in person at the workplace; however, online responses were also obtained in the industrial sector.

Each worker received a set of materials consisting of an informed consent form, ensuring anonymity and confidentiality, the research protocol (as previously described), and two envelopes, intended to allow workers to return the completed materials to the lead researcher while preserving the anonymity of their responses. Data collection took place between July and September 2023.

### 3.4. Data Analysis Strategy

All analyses were conducted using the statistical software *Statistical Package for the Social Sciences* (IBM® SPSS® Statistics, version 28.0). Specifically, inferential analyses were used to test associations between variables, and simple moderation analyses were performed to evaluate the effect of perceived barriers to PPE use and physical job demands, using Model 1 of the PROCESS macro for SPSS [68]. To test these moderation models, the bias-corrected bootstrap method with 5000 samples was applied.

## 4. Results

### 4.1. Descriptive and Correlational Analyses

Workers scored above the midpoint on all variables analyzed, except for perceived barriers to PPE use (Table 1). This result indicates that, in terms of SC, workers evaluate positively the implementation of SMS, management commitment, and their own participation in safety. On the other hand, they perceive few barriers to PPE use but report high physical job demands. Regarding psychometric characteristics, all analyzed variables showed good internal consistency, with Cronbach's alpha values ranging from 0.70 to 0.92.

**Table 1.** Correlations among variables included in the moderation models and respective Cronbach's alpha coefficients (presented diagonally).

Variables	M (SD)	1.	2.	3.	4.	5.
1. SMS	3.39 (0.60)	(0.89)				
2. Management	3.69 (0.74)	0.84 ***	(0.88)			
3. Workers	3.80 (0.55)	0.66 ***	0.67 ***	(0.70)		
4. Barriers	2.72 (0.81)	0.04	0.02	0.06	(0.84)	
5. Demands	3.65 (0.94)	−0.15 **	−0.11 *	0.00	0.20 ***	(0.92)

Note: SMS = Safety Management Systems; M = Mean; SD = Standard Deviation. \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .

As shown in Table 1, the various SC components presented positive correlations with one another, confirming hypotheses H1a and H1b. This means that the higher the perceived management commitment to safety, the better the perception of SMS implementation and the greater the worker participation in safety-related matters. In contrast, physical job demands were negatively correlated with both SMS and management commitment.

### 4.2. Moderation Analyses

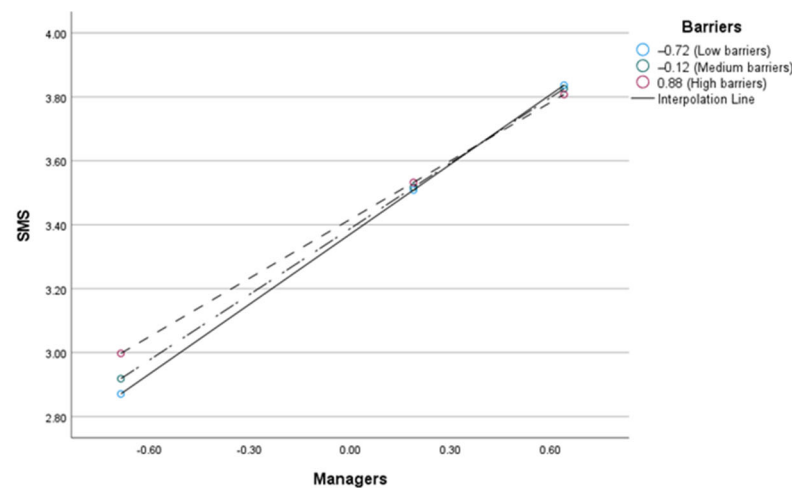
Regarding the moderation analyses, results indicated a moderating effect of perceived barriers to PPE use (Model 1:  $B = -0.07$ ,  $SE = 0.02$ ,  $t = 3.33$ ,  $p < 0.001$ ,  $f^2 = 0.02$ ) and physical job demands (Model 2:  $B = -0.05$ ,  $SE = 0.02$ ,  $t = -2.52$ ,  $p < 0.05$ ,  $f^2 = 0.01$ ) in the relationship between management commitment and SMS implementation, confirming hypotheses H2a and H2b, respectively (Table 2). However, it should be noted that in both models, the moderation effect size was very close to zero.

**Table 2.** Test of moderating variables in the relationship between management commitment and SMS implementation.

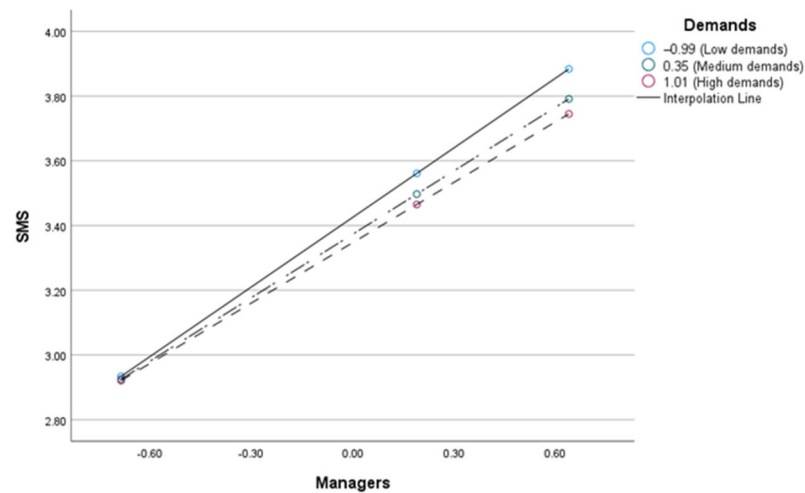
	<i>B</i>	SE	<i>t</i>	<i>p</i>	95% CI <sup>1</sup>	
					LLCI	ULCI
Model 1 (perceived barriers as moderator)						
Constant	3.39	0.02	229.69	***	3.36	3.42
Management	0.68	0.02	33.94	***	0.64	0.72
Barriers	0.03	0.02	1.52	0.13	−0.01	0.07
Management × Barriers	−0.07	0.02	−3.33	***	−0.12	−0.03
Model 2 (physical job demands as moderator)						
Constant	3.87	0.02	228.46	***	3.36	3.42
Management	0.67	0.02	33.48	***	0.63	0.71
Demands	−0.04	0.02	−2.47	*	−0.07	−0.01
Management × Demands	−0.05	0.02	−2.52	*	−0.09	−0.01

<sup>1</sup> Confidence intervals were estimated using the bootstrapping technique with 5000 samples. \*  $p < 0.05$ ; \*\*\*  $p < 0.001$ .

In Model 1, conditional effects showed that when perceived barriers to PPE use were very low, the relationship between management commitment and SMS was significant ( $B = 0.73$ ,  $SE = 0.03$ ,  $t = 27.61$ ,  $p < 0.001$ ). For moderate levels of perceived barriers, the relationship remained positive and significant ( $B = 0.69$ ,  $SE = 0.02$ ,  $t = 33.75$ ,  $p < 0.001$ ), as it did for higher levels ( $B = 0.61$ ,  $SE = 0.03$ ,  $t = 22.88$ ,  $p < 0.001$ ). Thus, even though the moderating effect is not strong, perceived barriers to PPE use appear to reduce the impact of management commitment on SMS implementation to some extent (Figure 2).

**Figure 2.** Moderating effect of perceived barriers to PPE use on the relationship between management commitment and SMS.

The conditional effects in Model 2 indicate that, similar to what was observed for PPE barriers, higher physical job demands weaken the positive relationship between management commitment and SMS (Figure 3). When physical demands were very low, the relationship was significant ( $B = 0.72$ ,  $SE = 0.03$ ,  $t = 25.31$ ,  $p < 0.001$ ). For moderate levels of demands, the relationship remained positive and significant ( $B = 0.65$ ,  $SE = 0.02$ ,  $t = 31.75$ ,  $p < 0.001$ ), as it did for high levels ( $B = 0.62$ ,  $SE = 0.03$ ,  $t = 23.37$ ,  $p < 0.001$ ).



**Figure 3.** Moderating effect of physical job demands on the relationship between management commitment and SMS.

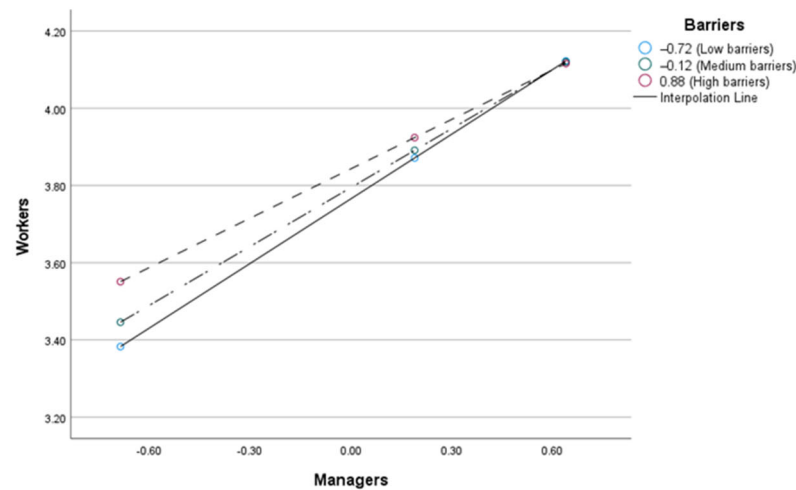
As in the relationship between management commitment and SMS, both perceived barriers to PPE use (Model 3:  $B = -0.08$ ,  $SE = 0.03$ ,  $t = -2.99$ ,  $p < 0.01$ ,  $f^2 = 0.02$ ) and physical job demands (Model 4:  $B = -0.05$ ,  $SE = 0.02$ ,  $t = -1.97$ ,  $p < 0.05$ ,  $f^2 = 0.01$ ) also showed a moderating role in the relationship between management commitment and worker participation, confirming hypotheses H3a and H3b (Table 3).

**Table 3.** Test of moderating variables in the relationship between management commitment and worker participation.

	<i>B</i>	<i>SE</i>	<i>t</i>	<i>p</i>	95% CI <sup>1</sup>	
					LLCI	ULCI
Model 3 (perceived barriers as moderator)						
Constant	3.80	0.02	206.18	***	3.77	3.84
Management	0.50	0.03	20.06	***	0.45	0.55
Barriers	0.05	0.02	2.05	*	0.00	0.10
Management × Barriers	−0.08	0.03	−2.99	**	−0.14	−0.03
Model 4 (physical job demands as moderator)						
Constant	3.80	0.02	204.71	***	3.76	3.83
Management	0.50	0.03	20.11	***	0.45	0.55
Demands	0.04	0.02	2.06	*	0.00	0.08
Management × Demands	−0.05	0.02	−1.97	*	−0.09	0.00

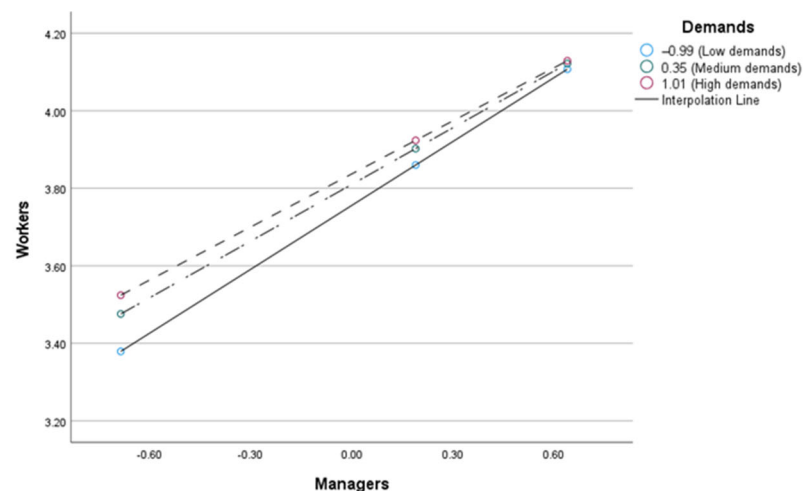
<sup>1</sup> Confidence intervals were estimated using the bootstrapping technique with 5000 samples. \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .

In Model 3, conditional effects showed that when perceived barriers to PPE use were very low, the relationship between management commitment and worker participation was significant ( $B = 0.56$ ,  $SE = 0.03$ ,  $t = 16.93$ ,  $p < 0.001$ ). For moderate levels of perceived barriers, the relationship remained positive and significant ( $B = 0.51$ ,  $SE = 0.03$ ,  $t = 20.09$ ,  $p < 0.001$ ), as it did for high levels ( $B = 0.43$ ,  $SE = 0.03$ ,  $t = 12.79$ ,  $p < 0.001$ ). Thus, although the moderation effect is not very strong, perceived barriers to PPE use seem to attenuate the impact of management commitment on worker participation in safety (Figure 4).



**Figure 4.** Moderating effect of perceived barriers to PPE use on the relationship between management commitment and worker participation.

Similarly, the conditional effects in Model 4 indicate that higher physical job demands weaken the positive relationship between management commitment and worker participation in safety (Figure 5). When physical demands were very low, the relationship was significant ( $B = 0.55$ ,  $SE = 0.04$ ,  $t = 15.51$ ,  $p < 0.001$ ). For moderate levels, the relationship remained positive and significant ( $B = 0.49$ ,  $SE = 0.03$ ,  $t = 18.92$ ,  $p < 0.001$ ), and for high levels, it also remained significant ( $B = 0.46$ ,  $SE = 0.03$ ,  $t = 13.70$ ,  $p < 0.001$ ).



**Figure 5.** Moderating effect of physical job demands on the relationship between management commitment and worker participation.

## 5. Discussion

The results of the present study indicate, with regard to the first objective, that the various dimensions of SC are positively related, with management commitment emerging as a key factor across the analyses conducted. On one hand, a positive relationship was found between management commitment and SMS implementation, which is consistent with the literature [17,32,45]. This relationship may be explained by the fact that SMS are often organized and/or supervised by managers. Therefore, when management fails to demonstrate a clear commitment to safety, the implementation and subsequent success of SMS may be compromised, affecting the organization's effectiveness and sustainability in this domain. This finding is also consistent with the Sociotechnical Systems Theory (STS), which emphasizes that organizational effectiveness results from the alignment of technical

systems (such as safety management structures) and social systems (such as leadership and worker engagement) [69]. From this perspective, management commitment becomes a central element in ensuring that SMS are not only technically implemented but also socially supported and embedded in the broader work system [70,71]. This systems-oriented view has gained increasing relevance in the safety domain, highlighting that sustainable safety performance emerges when social and technical subsystems are harmonized and mutually reinforcing.

On the other hand, management commitment was also positively related to worker participation in safety. This result may be explained by the fact that workers' attitudes and behaviors in organizational contexts are strongly influenced by the attitudes and behaviors of their direct supervisors. When workers perceive that management is actively involved in promoting safety and creating a secure work environment, they tend to adopt congruent behaviors, such as participating in preventive initiatives and reporting risky situations [24,39].

With regard to the second and third objectives, the results showed that perceived barriers to PPE use and physical job demands moderate the relationships between management commitment and the other SC dimensions—SMS and worker participation—however, this effect is small. In terms of perceived barriers to PPE use, when workers perceive significant obstacles to the appropriate use of safety equipment, it may become more difficult to implement SMS or to encourage active worker participation in safety matters. As noted by authors such as Al-Bayati [27] and Atasoy et al. [28], the perception of constraints related to preventive measures or safe work environments can compromise the development of a strong and functional SC. Similarly, when workers perceive high physical demands associated with their job, such as intense physical effort or repetitive tasks, their ability to consistently maintain safe behaviors may be affected. These findings are in line with the research of Seo et al. [15] and Kwon et al. [57], who identify physical demands as factors that deplete workers' physical and psychological resources, thereby limiting their engagement in safety practices.

Although statistically significant, the observed moderation effects showed small magnitudes. According to Cohen's guidelines [72], the calculated effect sizes correspond to weak effects. However, in the field of occupational safety, even small effects may have practical implications, particularly when they concern working conditions and behaviors that are critical to safety. Thus, while the influence of the moderators appears modest in statistical terms, these results contribute to a better understanding of the contextual mechanisms that can enhance or constrain the impact of management commitment on both the implementation of SMS and worker participation in safety-related practices.

Building on these findings, it is important to emphasize that the role of management remains relevant, even when workers face increased demands or barriers. Management commitment may act as a compensatory factor, capable of mitigating the negative effects of contextual constraints that threaten safety behaviors and the well-being of both workers and organizations. This compensatory effect may be framed within the Conservation of Resources Theory [73]. According to this theory, in high-demand environments, organizational resources—such as management support—become particularly important in protecting well-being and promoting safe behaviors. Thus, the results of this study suggest that even in physically demanding contexts and in the presence of obstacles to the implementation of preventive measures, the consistent prioritization of safety by management constitutes a central resource in fostering healthier and more sustainable workplaces.

### 5.1. Theoretical and Practical Implications

From a theoretical perspective, this study contributes to the deepening of knowledge about the dynamics of SC, being one of the first (if not the very first) in the Portuguese context to explore the moderating role of contextual work characteristics in the relationship between various SC components. The results also reinforce the central role of management commitment as a structuring variable capable of positively influencing the effectiveness of SMS and worker engagement, even in adverse conditions.

From a practical standpoint, the results highlight the need to intervene and strengthen organizational SC, particularly by reinforcing management commitment. One of the first steps may involve ensuring coherence between institutional values and operational practices. In this regard, the values upheld by the organization should be translated into concrete behaviors, both on the part of managers and workers. Furthermore, it is essential to ensure that management understands their role as safety promoters, and they should receive specific training in this area. Training programs on musculoskeletal injury prevention, proper PPE use, and leadership development are examples of initiatives with potential positive impact [74,75]. However, OHS training should also be extended to workers, fostering proactive attitudes and preventive behaviors.

Despite the relevance of the managerial role, organizations must also invest in the development of well-structured and effective SMS that integrate the specificities of job functions, work contexts, and worker profiles, ensuring practical applicability aligned with organizational reality. For instance, within the same workplace, there may be different age groups, education levels, or job types, which require that safety procedures, while grounded in a common system, remain sufficiently flexible to accommodate this diversity. Such adaptability increases the likelihood of worker adherence and enhances the effectiveness of preventive measures. Regarding the importance of SMS, Yoon et al. [76] found that, between 2006 and 2011, the rates of work accidents and fatal accidents decreased significantly following the implementation of SMS in the 100 largest construction companies in South Korea.

Finally, with respect to the moderating factors identified, it is crucial to adopt measures that minimize perceived barriers to PPE use by improving the ergonomic quality of equipment and ensuring its suitability for real working conditions [3,27,54]. Similarly, efforts should be made to alleviate physical job demands whenever possible by promoting work organization strategies that safeguard workers' physical health [15,57].

### 5.2. Limitations and Suggestions for Future Research

When interpreting the results obtained, some limitations should be taken into account. First, the study sample was limited to two sectors of activity, and when considered separately, each sector had a relatively small number of participants. In the future, efforts should be made to expand the sample by including other sectors of activity and increasing the number of participants within each sector. Additionally, data collection was confined to a single geographic region in Portugal, which may limit the generalizability of the findings to other regions. Future studies could benefit from expanding the sample to different regions and/or countries, allowing for the analysis of potential geographic specificities and the adaptation of safety strategies to organizational and cultural diversity.

Another limitation concerns the exclusive use of self-report questionnaires, which may introduce subjective biases, such as social desirability. Future research could incorporate complementary data collection methods, such as workplace observations and interviews with workers and management, thereby enhancing the robustness and validity of the findings.

Furthermore, the cross-sectional design of this study limits the ability to establish causal relationships. Future investigations could employ longitudinal designs to better understand how the dynamics between management commitment, contextual factors, and safety behaviors evolve over time. Finally, it would be of interest to extend the research to include other types of workplace risks—not only physical but also psychosocial or ergonomic—since different occupational settings may pose distinct challenges to SC.

## 6. Conclusions

This study reinforces the importance of understanding SC as a multidimensional phenomenon, in which management commitment plays a central role in the effectiveness of SMS implementation and worker participation in safety practices. The findings show that when workers perceive a high level of commitment from management, there is a greater likelihood that SMS will be implemented effectively and that workers themselves will show increased adherence to preventive practices. Additionally, the study revealed that contextual factors, such as perceived barriers to PPE use and physical job demands, influence these relationships by moderating the impact of management commitment on the other SC dimensions. Although the observed moderating effects were statistically significant but of small magnitude, the results highlight the importance of considering the real and operational contexts in which workers are embedded. Even in the face of operational obstacles, management commitment remains a critical organizational resource, capable of mitigating the negative impact of adverse conditions and promoting safer and more sustainable work environments.

This study thus contributes to the consolidation of knowledge about the factors that shape SC in organizations, underscoring the relevance of management as key agents, and the need to design interventions that integrate both formal safety management practices and the concrete challenges faced in the field. By simultaneously considering human, organizational, and contextual factors, this research offers an integrated perspective that can guide future strategies for promoting occupational safety, with a direct impact on workers' health, well-being, and performance.

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## Abbreviations

The following abbreviations are used in this manuscript:

SC	Safety culture
SMS	Safety management systems
PPE	Personal protective equipment
SDG	Sustainable development goal
OHS	Occupational health and safety

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