

## ***Triad Triggers of Clinical Injury: The Effect of Workload and Organizational Culture on Needle Stick Injury through Risk Perception***

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### **Abstract**

*Needle stick injury (NSI) remains a major occupational health issue among healthcare workers due to frequent exposure to sharp instruments and biological hazards. This study examines the direct and indirect effects of workload and organizational culture on needle stick injury through risk perception among healthcare workers in Denpasar City, Indonesia. A quantitative associative causal design was applied using Partial Least Squares–Structural Equation Modeling (PLS-SEM) with SmartPLS 4.0. Data were collected from 126 healthcare professionals, including physicians, dentists, nurses, and midwives, using a structured questionnaire. The results showed that workload significantly increased risk perception, whereas workload and organizational culture did not directly affect needle stick injury. Risk perception was found to have a significant positive association with needle stick injury, indicating that heightened awareness of occupational hazards tends to emerge alongside greater exposure to risky clinical situations. In addition, risk perception significantly mediated the relationship between workload and needle stick injury, but did not mediate the effect of organizational culture on injury occurrence. These findings demonstrate that needle stick injury is influenced by the interaction between workload pressures and healthcare workers' psychological responses. The study contributes empirical evidence supporting the integration of workload management and systemic safety interventions to improve occupational safety practices in healthcare settings.*

**Keywords:** *Needle Stick Injury, Workload, Organizational Culture, Risk Perception, Occupational Safety, Swiss Cheese Model, Healthcare Workers*

## **1. Introduction**

Occupational safety and health (OSH) remains a major global concern in the world of work. The International Labour Organization (ILO) estimates that approximately 2.93 million workers die annually due to work-related causes, while around 395 million workers experience non-fatal occupational injuries each year. In Indonesia, data from BPJS Ketenagakerjaan indicate a continuous increase in occupational accident cases, rising from 182,835 cases in 2019 to 221,740 in 2020, 234,370 in 2021, and 297,725 in 2022. This upward trend reflects the persistent vulnerability of workers to occupational hazards and highlights the need for strengthened prevention strategies. In the regulatory context, Government Regulation No. 50 of 2012 defines the Occupational Safety and Health Management System (SMK3) as an integral component of organizational management to control work-related risks and create safe, efficient, and productive workplaces. Furthermore, Government Regulation No. 88 of 2019 emphasizes occupational health protection to prevent work-related diseases and adverse health effects caused by workplace exposure.

Within the healthcare sector, occupational risks are particularly significant due to frequent exposure to biological hazards. The World Health Organization (WHO) estimates that approximately 16 billion injections are administered globally each year (Hassan et al., 2018). As a consequence, more than two million healthcare workers experience needle stick injuries (NSIs) annually. A meta-analysis of 87 studies conducted between 2008 and 2018 reported a global

annual prevalence of 44.5%, with the highest prevalence in Southeast Asia, dentists as the most at-risk group, and hypodermic needles as the primary cause (Bouya et al., 2020). NSIs contribute substantially to the transmission of blood-borne infections, accounting for approximately 39% of hepatitis C cases, 37% of hepatitis B cases, and 4.4% of HIV infections among healthcare workers due to occupational exposure (WHO). Additionally, the global prevalence of acute hepatitis B infection among healthcare workers reaches 5.3%, underscoring the magnitude of occupational disease burden in healthcare settings. Beyond hepatitis B, hepatitis C, and HIV, NSIs are also associated with cytomegalovirus, herpes simplex virus, and parvovirus B19 infections (Mengistu & Tolera, 2020).

A further concern is the high rate of underreporting of NSIs. Studies indicate that approximately 46% of needle stick injuries are not reported, with non-reporting more common among senior physicians, male healthcare workers, individuals over 51 years of age, and those lacking specific NSI training (Bahat et al., 2021). A meta-analysis involving 41 studies and 19,635 healthcare workers reported a pooled underreporting prevalence of 59.9%, with the most common reason being the perception that the incident was not serious. This high level of underreporting not only obscures the true incidence of NSIs but also weakens surveillance systems and prevention programs, reinforcing the urgency of identifying underlying systemic and behavioral determinants.

From a theoretical perspective, occupational accidents should be analyzed using a complex systems approach. Reason's Swiss Cheese Model explains that accidents occur due to failures at multiple levels, including unsafe acts, preconditions for unsafe acts, supervisory factors, and organizational influences (Wiegmann et al., 2022). In line with this model, needle stick injuries may result from the interaction between individual behavior, environmental conditions, supervisory practices, and organizational culture. Empirical evidence shows that workload is a significant predictor of NSIs. Additional workload and time pressure have been found to positively and significantly influence the occurrence of NSIs (Negash et al., 2024; Bazie, 2020). Mental workload has also been associated with increased NSI risk (Poku et al., 2025), and a 35% increase in NSIs has been reported with rising mental workload (Hosseinabadi et al., 2019). A systematic review further confirmed the significant association between workload and NSIs (Mengistu & Tolera, 2020). However, inconsistent findings remain. Some studies report that workload fatigue does not significantly correlate with NSI incidence (Mustapa et al., 2023), and workload measured by patient numbers and weekly working hours showed no significant effect (Priyangani et al., 2017). Similarly, Alemaheyu et al. (2023) found that the relationship between workload and NSIs changed direction after controlling for other variables.

Organizational culture has also been identified as a determinant of occupational injuries. Companies with stronger safety cultures report significantly lower injury and illness rates (Haga et al., 2024). Organizational-level interventions have demonstrated significant reductions in NSI incidence compared to pre-intervention periods (d'Ettoire et al., 2020). Nevertheless, other studies indicate that not all dimensions of organizational culture exert statistically significant effects on workplace accidents (Poku et al., 2023), suggesting inconsistent empirical evidence.

In addition to workload and organizational culture, risk perception plays an important behavioral role in occupational injury. Risk perception has been significantly associated with occupational accidents among healthcare workers (Maturrano et al., 2023). Moderate levels of risk perception have been linked to increased NSI occurrence (Isse et al., 2025), and healthcare workers with low or moderate risk perception demonstrate greater vulnerability to NSIs compared to those with high risk awareness (Alemaheyu et al., 2022). These findings suggest that the inability to accurately recognize and assess hazards may reduce vigilance during clinical procedures.

Despite the growing body of literature, previous studies examining the relationship between workload and NSIs, as well as organizational culture and NSIs, have produced inconsistent findings. This inconsistency indicates a research gap regarding the mechanisms underlying these relationships. Risk perception may function as a mediating variable that explains how workload and organizational culture influence NSI occurrence. High workload may reduce concentration and increase injury risk, particularly when risk perception is low. Conversely, a strong organizational safety culture may enhance risk perception through the internalization of safety values and procedures, thereby reducing NSI risk.

Therefore, this study is urgent and relevant, particularly in Denpasar City, Bali Province, which recorded 7,647 healthcare workers across 87 healthcare facilities in 2023, representing the highest concentration in the region. The intensity of healthcare services and frequent patient interactions increase potential occupational exposure. The novelty of this research lies in integrating workload and organizational culture within a triadic framework by positioning risk perception as a mediating variable grounded in the Swiss Cheese Model. The objective of this study is to comprehensively analyze the direct and indirect effects of workload and organizational culture on needle stick injuries through risk perception among healthcare workers.

## **2. Literature Review**

### **Reason's Accident Causation Theory**

Reason's Accident Causation Theory, introduced by Reason, explains that errors and failures may occur at multiple levels within an organization. When these failures align sequentially and interact with one another, they create conditions that allow accidents to occur. Contributing factors are not limited to human limitations or unsafe environmental conditions but also include weaknesses in management functions and inadequate system design (Karimi et al., 2021).

The core concept of this theory emphasizes the existence of multiple layers of defense, metaphorically illustrated as slices of Swiss cheese with holes symbolizing potential weaknesses. This metaphor has proven useful in visualizing how errors and failures may occur within complex systems (Shabani et al., 2023). According to Reason, accidents in complex socio-technical systems, including healthcare, generally result from the weakening or malfunctioning of safety barriers across four levels: **Unsafe Acts**, **Preconditions for Unsafe Acts**, **Supervisory Factors**, and **Organizational Influences** (Wiegmann et al., 2022). Over time, Reason's model—now widely known as the Swiss Cheese Model—has become a dominant paradigm in analyzing medical errors and patient safety incidents (Perneger, 2005).

Human error plays a substantial role in accident occurrence. Integrating human factors into the Swiss Cheese Model expands understanding of risk sources by examining individual performance, worker involvement in decision-making, workload evaluation, and other cognitive aspects influencing the effectiveness of each defensive layer (Shabani et al., 2023). Organizations are therefore encouraged to systematically incorporate human factors into risk management processes, including the identification of cognitive biases and the influence of organizational culture on risk evaluation. Continuous improvement through regular review of safety layers, identification of new vulnerabilities, and learning from past incidents is essential to strengthen risk management practices (Shabani et al., 2023).

In this study, workload, organizational culture, risk perception, and needle stick injury are mapped into the Swiss Cheese Model framework. Workload is conceptualized as part of **organizational influences**, reflecting structural pressures that create latent conditions. Organizational culture is associated with **supervisory and managerial influences**, shaping norms and safety priorities. Risk perception represents **preconditions for unsafe acts**, as it influences

vigilance and cognitive readiness. Needle stick injury (NSI) is positioned as an **unsafe act outcome**, resulting from the interaction of these layered factors.

However, this study does not adopt the Swiss Cheese Model in its original rigid structure. Instead, it adapts the model conceptually while preserving its essential premise: occupational accidents result from layered interactions among organizational, environmental, and individual factors. Workload creates physical and psychological strain that may increase error probability. Organizational culture shapes safety values and monitoring systems. Risk perception functions as the psychological mechanism linking structural conditions to individual behavior. Thus, NSIs are not isolated events but represent the cumulative outcome of interacting systemic layers, consistent with the Swiss Cheese Model.

### **The Cultural Theory of Risk**

The Cultural Theory of Risk, introduced by Douglas (1978) and further developed by Douglas and Wildavsky (1983), examines how cultural contexts shape the way individuals and social groups interpret and respond to risk according to their shared value systems and worldviews. The theory proposes four primary cultural biases influencing risk perception and response through social structures and institutions: **hierarchical**, **individualistic**, **egalitarian**, and **fatalistic** cultures (Rufat et al., 2025).

Douglas emphasized that culture plays a crucial role in risk analysis. She argued that societies hold deeply embedded views regarding risky situations, and simply providing additional information does not automatically change those beliefs. Douglas (1997) proposed a typology of social relations—later known as the Cultural Theory of Risk—to classify groups based on shared cultural perspectives (Garthwaite et al., 2023). This typology is constructed along two intersecting dimensions:

- The **group dimension**, reflecting the degree of collective integration (low group to high group),
- The **grid dimension**, reflecting the degree of social regulation or hierarchy (low grid to high grid) (Talwar, 2021).

Within this framework, risk perception is socially constructed rather than purely objective. In this study, Cultural Theory of Risk serves as the foundation for understanding how healthcare workers' safety judgments are shaped by organizational values and social dynamics. Risk is interpreted as a social construction influenced by shared norms, collective experiences, and institutional context.

Organizational culture functions as the social environment that frames how safety risks are interpreted and prioritized in clinical practice. Shared norms and structural arrangements influence what level of risk is considered acceptable and determine the consistency of safety behavior. Risk perception therefore operates as the mechanism explaining how organizational culture translates into behavioral outcomes such as compliance with safety procedures and caution in handling sharp instruments. Variations in risk perception ultimately influence the likelihood of needle stick injury through internalized risk evaluation during decision-making.

### **The Effect of Workload on Needle Stick Injury**

Workload arises from the interaction between task demands, the work environment, workers' skills, behaviors, and perceptions. It may also be professionally defined as the combination of task requirements and the efforts exerted to accomplish work activities (Mokodompit et al., 2019). In healthcare settings, workload encompasses physical demands, cognitive load, time pressure, and emotional strain, all of which may affect workers' safety performance. From a theoretical standpoint, Reason's Accident Causation Theory, widely known as the Swiss Cheese Model, provides a systemic explanation of how occupational

accidents occur. Organizations are viewed as having multiple defensive layers designed to prevent failure; however, each layer may contain weaknesses due to real-world complexity and dynamic conditions. Reason distinguishes between latent failures—originating from managerial decisions, flawed system design, inadequate resource allocation, or technological shortcomings—and active failures, which refer to unsafe acts or violations committed by frontline workers (Bracco & Ivaldi, 2023). Excessive workload may function as a latent organizational weakness that increases the likelihood of active failures, thereby contributing to needle stick injuries (NSIs). Empirical evidence largely supports a positive association between workload and NSIs. Several studies report that high workload significantly increases the incidence of NSIs (Negash et al., 2024; Poku et al., 2025; Ketshabile, 2022; Hosseinabadi et al., 2019; Vinchek et al., 2025; Bazie, 2020; Mapanawang et al., 2017; Pangalila et al., 2017; Isse et al., 2025). These findings suggest that time pressure, fatigue, and cognitive overload reduce vigilance and procedural compliance. However, inconsistent findings remain. Mustapa et al. (2023) and Priyangani et al. (2017) did not find a significant positive relationship between workload and NSIs. This inconsistency indicates that the relationship may be context-dependent and influenced by other intervening variables. Given the mixed empirical results and theoretical grounding in the Swiss Cheese Model, further investigation is required. Therefore, the following hypothesis is proposed:

*H1: Higher workload is associated with higher levels of needle stick injury.*

#### **The Effect of Workload on Risk Perception**

Increased workload is associated with elevated job pressure and reflects compensatory mechanisms in task performance. Under high workload conditions, employees may adopt strategies requiring lower cognitive effort to achieve performance targets, potentially making adherence to safety procedures more difficult. In such situations, workers tend to perceive higher levels of accident risk (Oah et al., 2018). Empirical evidence supports this relationship. Oah et al. (2018) found that workload positively influences both cognitive and emotional dimensions of risk perception. Similarly, Mao et al. (2025) reported a significant association between workload and increased occupational risk perception. High workload conditions—characterized by task intensity, time constraints, and operational complexity—may heighten workers' awareness of hazards embedded in their tasks. Increased exposure to demanding conditions may therefore strengthen individual sensitivity to potential dangers. Based on theoretical reasoning and empirical findings, the following hypothesis is formulated:

*H2: Higher workload is associated with higher levels of risk perception.*

#### **The Effect of Organizational Culture on Needle Stick Injury**

Organizational culture reflects shared patterns of thinking, feeling, and acting within healthcare organizations. Healthcare institutions often consist of multiple subcultures, which may either facilitate or hinder quality improvement and safety initiatives (Mannion & Davies, 2018). Organizational culture influences compliance with safety protocols, communication effectiveness, and risk management practices. Within the Swiss Cheese Model framework, latent conditions such as inadequate training, ineffective communication systems, equipment failures, flawed system design, insufficient human resources, and weak organizational culture contribute to accident causation (Shabani et al., 2023). Unlike active failures, latent conditions may remain hidden for extended periods before aligning with other weaknesses and resulting in incidents. Weak safety culture can therefore create systemic vulnerabilities that increase the risk of NSIs. Empirical studies support this view. d'Ettoire et al. (2020) found that organizational-level safety interventions significantly reduced NSI incidence. Conversely, Noh et al. (2023) reported that not all dimensions of organizational culture showed uniform statistical effects, indicating contextual variability. Variations in safety practices suggest that organizational values

and norms are not always consistently translated into safe behavior, potentially increasing NSI risk when safety mechanisms are weak. Accordingly, the hypothesis is formulated as follows:

*H3: A less conducive organizational culture is associated with higher levels of needle stick injury.*

### **The Effect of Organizational Culture on Risk Perception**

Organizational culture is widely recognized as a latent factor shaping work practices, attitudes, and behaviors. It represents collectively shared values, beliefs, and assumptions that guide how members interpret situations and respond to organizational environments (Edeh et al., 2025). According to Cultural Theory of Risk, risk is socially constructed. Individuals exposed to similar hazards may interpret risk differently depending on cultural biases embedded within their social context (McEvoy et al., 2017). Risk perception is therefore shaped by shared rules, norms, and conventions within organizations. In high-risk public service settings, frontline professionals frequently make autonomous decisions under uncertainty, and organizational culture strongly influences their perception and response to risk (Tangsgaard, 2021). Within the Swiss Cheese Model, the organizational layer represents cultural norms, safety policies, and management practices that shape how hazards are recognized and interpreted. A strong safety-oriented culture enhances vigilance and sensitivity to danger, whereas performance-driven or deviation-tolerant cultures may weaken risk perception. Empirical findings support this argument. Tangsgaard (2021) demonstrated that organizational culture plays a significant role in shaping risk perception and behavior in high-risk situations. Thus, the hypothesis is proposed:

*H4: A more conducive organizational culture is associated with higher levels of risk perception.*

### **The Effect of Risk Perception on Needle Stick Injury**

Risk perception refers to individuals' judgments and concerns about the likelihood of experiencing occupational accidents or work-related illnesses (Rundmo & Sjoberg, 1996, as cited in Oah et al., 2018). The Swiss Cheese Model and Cultural Theory of Risk provide complementary theoretical foundations for understanding the link between risk perception and NSIs. In the Swiss Cheese framework, insufficient vigilance may allow hazards to penetrate defensive layers. Risk perception influences attention, caution, and adherence to safety procedures when handling sharp instruments. Cultural Theory of Risk emphasizes that individuals' interpretation of danger shapes their behavioral responses. Empirical evidence indicates that inadequate risk perception increases vulnerability to NSIs (Mengistu et al., 2021). Maturrano et al. (2023) found that perceived occupational risk was associated with prior accident experience among nurses. Isse et al. (2025) reported that moderate risk perception levels were linked to higher NSI incidence, suggesting that insufficient or inaccurate risk appraisal may reduce preventive behavior. Therefore, the following hypothesis is proposed:

*H5: Lower risk perception is associated with higher levels of needle stick injury.*

### **The Mediating Role of Risk Perception in the Relationship Between Workload and Needle Stick Injury**

No prior studies have explicitly positioned risk perception as a mediator between workload and NSIs. However, this relationship can be conceptually explained through Reason's model. Errors occur when planned actions fail to achieve intended outcomes without random causes (Reason, 1990, as cited in Larouzee & Coze, 2020). The Swiss Cheese Model illustrates that accidents result from interconnected failures across organizational layers (Bracco & Ivaldi, 2023). High workload may function as a latent failure that increases fatigue and reduces concentration. Risk perception may serve as a psychological defensive layer mitigating these effects. Healthcare workers with high risk perception may remain cautious and adhere to safety procedures despite heavy workload, whereas low risk perception may amplify the negative effects of workload. Thus, the hypothesis is:

*H6: Risk perception mediates the relationship between workload and needle stick injury.*

### **The Mediating Role of Risk Perception in the Relationship Between Organizational Culture and Needle Stick Injury**

Although prior studies have not directly examined risk perception as a mediator between organizational culture and NSIs, the Swiss Cheese Model supports this conceptual linkage. Accidents occur when errors at different organizational levels align (Karimi et al., 2021). Organizational weaknesses influence frontline behavior through cultural norms and safety values. In this framework, risk perception functions as a psychological mechanism linking organizational culture to safe behavior. A positive safety culture enhances hazard awareness and preventive practices, thereby reducing NSI incidence. Conversely, weak culture may diminish risk perception and increase vulnerability. Accordingly, the final hypothesis is formulated as follows:

*H7: Risk perception mediates the relationship between organizational culture and needle stick injury.*

## **3. Methods**

### **Population and Sample**

The population of this study consists of all healthcare workers in Denpasar City, including general practitioners, specialists, dentists, nurses, and midwives. These professional groups were selected because they are directly involved in invasive clinical procedures such as injections, suturing, and other interventions involving sharp instruments, which place them at higher risk of experiencing needle stick injuries (NSIs). However, the exact number of healthcare workers in Denpasar in 2025 is not comprehensively available in publicly published institutional data. Due to the absence of an updated sampling frame and precise population size, this study applied an unknown population approach in determining the sample size to ensure adequate representation.

The sample size was determined using the Lemeshow formula for a single population proportion, which is commonly applied in studies involving large or unknown populations. This formula estimates the minimum sample size required to achieve a specified confidence level and acceptable margin of error. Using a 95% confidence level ( $Z = 1.96$ ), an assumed proportion ( $p$ ) of 0.5 due to the absence of local prevalence data, and a margin of error ( $d$ ) of 0.10, the calculation resulted in a minimum required sample size of 96.04, which was rounded up to 97 respondents. To anticipate potential non-response or incomplete questionnaire responses, the final sample size was increased to 100 respondents. The study therefore involved 100 healthcare workers who met the inclusion criteria. Respondents were required to voluntarily agree to participate, either through an online questionnaire distributed via Google Forms or through a printed questionnaire distributed directly. Additionally, respondents had to be healthcare professionals working in healthcare facilities within Denpasar City and must have previously experienced a needle stick injury during their professional practice. These criteria ensured that the collected data were relevant and aligned with the objectives of the study.

### **Research Variables**

This study involves four primary variables that were identified based on the proposed hypotheses. Workload ( $X_1$ ) and organizational culture ( $X_2$ ) function as independent variables, needle stick injury ( $Y$ ) serves as the dependent variable, and risk perception ( $M$ ) operates as a mediating variable. The interaction among these variables is examined to understand both direct and indirect effects within the proposed structural model.

Operational definitions were developed to ensure conceptual clarity and measurement accuracy. Needle stick injury refers to the occurrence of skin puncture caused by used needles during professional healthcare practice. Indicators were adapted from Alfulayw et al. (2021) and Singh et al. (2024), covering incidents occurring during needle use, recapping, and disposal processes. Workload is defined as the perceived level of physical, mental, and emotional demands experienced while performing job responsibilities. Indicators adapted from Effendi et al. (2025) include workload inconsistency, burnout, and work-life balance, reflecting time pressure, task overload, fatigue, and imbalance between professional and personal life. Organizational culture refers to shared values, norms, and practices collectively embraced within healthcare institutions. Based on Sulila (2022) and Robbins and Coulter (2009), indicators include attention to detail, outcome orientation, and team orientation. Risk perception refers to an individual's subjective assessment of hazard likelihood and severity. Indicators derived from Zhang et al. (2024) include hazard identification level, deviation from expected harm, and risk evaluation deviation, reflecting the cognitive ability to recognize and evaluate workplace risks.

### **Data Collection Method**

Data were collected using a survey approach through the distribution of structured questionnaires to healthcare workers in Denpasar City. This method was selected due to its efficiency in gathering data from a relatively large number of respondents within a limited period. The questionnaire was developed based on validated indicators derived from relevant theoretical frameworks and previous empirical studies. Distribution was conducted through two modes: online distribution using Google Forms and offline distribution through printed questionnaires delivered directly to healthcare facilities. Before completing the questionnaire, respondents were informed about the research objectives, procedures, and confidentiality assurances. Data collection continued until the predetermined sample size of 100 respondents was achieved.

### **Research Instrument**

The primary research instrument used in this study was a structured questionnaire employing a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Each statement item was designed to represent specific conceptual dimensions of the research variables. The instrument was developed carefully to ensure contextual relevance to healthcare settings and clarity of interpretation. The use of a Likert scale enables quantitative data processing and objective measurement of respondents' perceptions, experiences, and attitudes toward workload, organizational culture, risk perception, and needle stick injury. The collected data were subsequently analyzed using Partial Least Squares (PLS) to evaluate the structural relationships among variables.

### **Data Analysis Technique**

This study employed Structural Equation Modeling (SEM) using the Partial Least Squares (PLS) approach with SmartPLS 4.0 software. PLS-SEM was selected because of its flexibility in handling complex models with multiple constructs and its suitability for relatively small sample sizes. According to Hair et al. (2021), PLS-SEM analysis involves three main stages: evaluation of the measurement model (outer model), evaluation of the structural model (inner model), and mediation analysis.

The measurement model evaluation assessed convergent validity, discriminant validity, and composite reliability. Convergent validity was examined through outer loading values and Average Variance Extracted (AVE), where outer loadings of 0.708 or higher and AVE values above 0.50 indicate adequate validity. Discriminant validity was evaluated using the Heterotrait-

Monotrait Ratio (HTMT), with acceptable thresholds below 0.85 or 0.90. Composite reliability values between 0.70 and 0.90 indicate satisfactory internal consistency.

The structural model evaluation examined collinearity, coefficient of determination ( $R^2$ ), effect size ( $f^2$ ), and predictive relevance ( $Q^2$ ). Collinearity was assessed using the Variance Inflation Factor (VIF), with recommended values below 5. The  $R^2$  value indicates the predictive power of exogenous variables on endogenous variables, with 0.75 considered substantial, 0.50 moderate, and 0.25 weak. Effect size ( $f^2$ ) values of 0.02, 0.15, and 0.35 represent small, medium, and large effects, respectively. Predictive relevance ( $Q^2$ ) was assessed using blindfolding procedures, where values greater than zero indicate acceptable predictive capability.

Mediation analysis was conducted using bootstrapping procedures to test indirect effects. The significance of mediation was evaluated based on path coefficients, t-statistics, and p-values. Full mediation occurs when only the indirect effect is significant, partial mediation occurs when both direct and indirect effects are significant, and no mediation is concluded when the indirect effect is not significant (Hair et al., 2021).

#### 4. Results and Discussion

##### Respondent Characteristics

The characteristics of respondents in this study describe the profile of 126 participants who were involved in the data collection process by completing questionnaires distributed online through Google Forms. The respondent profile includes information regarding age and professional occupation. The detailed characteristics are systematically presented in Table 4.1.

**Table 1. Respondent Characteristics**

| No | Characteristic | Classification | Number of Respondents | Percentage |
|----|----------------|----------------|-----------------------|------------|
| 1  | Age            | 20–25          | 73                    | 57.94%     |
|    |                | 25–30          | 43                    | 34.13%     |
|    |                | 30–35          | 8                     | 6.35%      |
|    |                | 35–40          | 1                     | 0.79%      |
|    |                | >40            | 1                     | 0.79%      |
| 2  | Occupation     | Doctor         | 53                    | 42.06%     |
|    |                | Dentist        | 9                     | 7.14%      |
|    |                | Nurse          | 57                    | 45.24%     |
|    |                | Midwife        | 7                     | 5.56%      |

The majority of respondents were aged between 20 and 25 years, accounting for 57.94% of the total sample, followed by those aged 25 to 30 years at 34.13%. Respondents aged 30 to 35 years represented 6.35%, while those aged 35 to 40 years and above 40 years each accounted for 0.79% of the sample. Based on professional occupation, most respondents were nurses (45.24%), followed by doctors (42.06%). Dentists accounted for 7.14% of respondents, while midwives represented 5.56%. These findings indicate that the sample was predominantly composed of young healthcare professionals, particularly nurses and doctors, who are actively engaged in clinical procedures and therefore relevant to the context of needle stick injury risk.

##### Outer Model Evaluation

##### Convergent Validity Test

Convergent validity in the reflective measurement model aims to assess the extent to which the indicators used are capable of representing the measured latent construct. Referring to Hair et al. (2021), convergent validity can be evaluated through outer loading values, which reflect the strength of the relationship between indicators and their respective constructs.

**Table 2. Instrument Validity Test Results: Outer Loadings and AVE**

| Variable Name          | Indicator                               | Item Code | Outer Loading | AVE   |
|------------------------|---|-----------|---------------|-------|
| Needle Stick Injury    | During Use                              | Y1.1      | 0.680         | 0.521 |
|                        |   | Y1.2      | 0.725         |       |
|                        | Recapping                               | Y2.1      | 0.587         |       |
|                        |   | Y2.2      | 0.573         |       |
|                        |   | Y2.3      | 0.786         |       |
|                        | During Disposal                         | Y3.1      | 0.811         |       |
|                        |   | Y3.2      | 0.842         |       |
| Workload               | Workload Inconsistency                  | BK1.1     | 0.790         | 0.568 |
|                        |   | BK1.2     | 0.794         |       |
|                        |   | BK1.3     | 0.707         |       |
|                        | Work Fatigue                            | BK2.1     | 0.715         |       |
|                        |   | BK2.3     | 0.751         |       |
|                        | Work Balance                            | BK3.1     | 0.772         |       |
|                        |   | BK3.2     | 0.743         |       |
| Organizational Culture | Attention to Detail                     | BO1.1     | 0.945         | 0.576 |
|                        |   | BO1.2     | 0.698         |       |
|                        | Result Orientation                      | BO2.1     | 0.612         |       |
|                        |   | BO2.2     | 0.783         |       |
|                        | Team Orientation                        | BO3.1     | 0.669         |       |
|                        |   | BO3.2     | 0.801         |       |
| Risk Perception        | Level of Hazard Identification          | PR1.1     | 0.817         | 0.599 |
|                        |   | PR1.2     | 0.788         |       |
|                        | Level of Deviation from Expected Damage | PR2.2     | 0.724         |       |
|                        |   | PR2.3     | 0.831         |       |
|                        |   | PR3.2     | 0.751         |       |
|                        | Level of Risk Evaluation Deviation      | PR3.3     | 0.725         |       |

Based on Table 2, all constructs have AVE values above 0.50, indicating that each construct explains more than 50% of the variance of its indicators. Most outer loading values meet the recommended threshold, and indicators below 0.70 remain acceptable as they do not reduce the AVE below the required level. Therefore, the constructs of Needle Stick Injury, Workload, Organizational Culture, and Risk Perception meet the convergent validity criteria.

**Reliability Test**

The reliability test was conducted to assess the level of internal consistency of indicators in measuring latent constructs in the reflective measurement model. In PLS-SEM, internal reliability can be evaluated using Cronbach’s Alpha, rho\_a, and Composite Reliability (rho\_c), where values above 0.70 indicate that the construct has adequate reliability and that the indicators are able to measure the construct consistently (Hair et al., 2021).

**Table 3. Reliability Test Results**

| Variable            | Cronbach’s Alpha | rho_a | rho_c | Description |
|---------------------|------------------|-------|-------|-------------|
| Needle Stick Injury | 0.844            | 0.866 | 0.882 | Reliable    |

|                        |       |       |       |          |
|------------------------|-------|-------|-------|----------|
| Workload               | 0.873 | 0.875 | 0.902 | Reliable |
| Organizational Culture | 0.891 | 0.980 | 0.889 | Reliable |
| Risk Perception        | 0.865 | 0.868 | 0.899 | Reliable |

Based on Table 3, all research constructs—Needle Stick Injury, Workload, Organizational Culture, and Risk Perception—show Cronbach’s Alpha, rho\_a, and rho\_c values above the minimum threshold of 0.70. These results indicate that all constructs have good internal reliability, so the indicators used are considered consistent and suitable for testing in the structural model stage (Hair et al., 2021).

**Discriminant Validity Test**

The discriminant validity test was conducted to ensure that each construct in the reflective measurement model has adequate empirical distinction from other constructs. Evaluation was conducted using the Heterotrait-Monotrait Ratio (HTMT) and cross-loading of indicators. Discriminant validity is considered fulfilled if the HTMT value is < 0.90 and each indicator shows the highest outer loading on the construct it measures compared to other constructs.

**Table 4. Discriminant Validity – HTMT**

|                        | Workload | Organizational Culture | Needle Stick Injury | Risk Perception |
|------------------------|----------|------------------------|---------------------|-----------------|
| Workload               |          |                        |                     |                 |
| Organizational Culture | 0.175    |                        |                     |                 |
| Needle Stick Injury    | 0.744    | 0.152                  |                     |                 |
| Risk Perception        | 0.885    | 0.175                  | 0.859               |                 |

Based on the HTMT results, all HTMT values between constructs are below the established threshold. This indicates that the constructs of Workload, Organizational Culture, Needle Stick Injury, and Risk Perception are empirically distinct from one another. Therefore, all constructs in the research model meet the discriminant validity criteria.

**Inner Model Evaluation**

**Multicollinearity Test**

The multicollinearity test was conducted to ensure that there is no collinearity among predictor constructs in the structural model, as high collinearity may affect the stability of path coefficient estimates. In PLS-SEM, multicollinearity is evaluated using the Variance Inflation Factor (VIF), where values below 5 indicate that the model does not suffer from multicollinearity issues.

**Table 5. Multicollinearity Test Results**

|  | VIF   |
|--|-------|
| Workload → Needle Stick Injury               | 2.507 |
| Workload → Risk Perception                   | 1.041 |
| Organizational Culture → Needle Stick Injury | 1.057 |
| Organizational Culture → Risk Perception     | 1.041 |
| Risk Perception → Needle Stick Injury        | 2.542 |

Based on Table 5, all VIF values for the relationships between constructs are below the recommended threshold. This finding indicates that there is no multicollinearity problem among

predictor constructs, allowing the structural model estimates to be interpreted reliably and stably.

**Goodness of Fit (R-Square) and Predictive Q-Square**

The Goodness of Fit test in the structural model of PLS-SEM is evaluated using the R-square and adjusted R-square values to assess the ability of predictor constructs to explain the variance of endogenous constructs. The R-square value indicates the proportion of variance in the endogenous construct that can be explained by exogenous constructs in the model (Hair et al., 2021).

**Table 6. Goodness of Fit Results**

|                       | R-square | R-square adjusted |
|-----------------------|----------|-------------------|
| Needle Stick Injury_Y | 0.577    | 0.566             |
| Risk Perception_M     | 0.607    | 0.600             |

Based on the test results, the Needle Stick Injury construct has an R-square value of 0.577 and an adjusted R-square value of 0.566. This indicates that 57.7% of the variance in Needle Stick Injury can be explained by the predictor constructs in the model. Meanwhile, the Risk Perception construct has an R-square value of 0.607 and an adjusted R-square value of 0.600, indicating that 60.7% of the variance in Risk Perception can be explained by the exogenous constructs included in the model. Overall, these R-square values demonstrate that the structural model has moderate to strong explanatory power for the endogenous constructs tested. Predictive relevance in PLS-SEM is evaluated using Stone-Geisser’s Q<sup>2</sup> criterion obtained through the blindfolding procedure. According to Hair et al. (2021), Q<sup>2</sup> values are used to assess the predictive capability of the structural model for endogenous constructs based on omitted data points that are subsequently predicted by the model. A model is considered to have predictive relevance if Q<sup>2</sup> > 0. Threshold values of 0.02 indicate small predictive relevance, 0.15 indicate medium predictive relevance, and 0.35 indicate large predictive relevance.

**Table 7. Predictive Relevance Test Results**

| Construct                   | SSO     | SSE     | Q <sup>2</sup> |
|-----------------------------|---------|---------|----------------|
| Workload (X1)               | 882.000 | 882.000 | 0.000          |
| Organizational Culture (X2) | 756.000 | 756.000 | 0.000          |
| Needle Stick Injury (Y)     | 882.000 | 637.792 | 0.277          |
| Risk Perception (M)         | 756.000 | 489.856 | 0.352          |

The predictive relevance results show that the Needle Stick Injury construct has a Q<sup>2</sup> value of 0.277, which falls into the medium predictive relevance category. The Risk Perception construct has a Q<sup>2</sup> value of 0.352, which falls into the large predictive relevance category, indicating its substantial predictive role as a mediating variable in the model. The Workload and Organizational Culture constructs have Q<sup>2</sup> values of 0.000, which is acceptable because these constructs function as exogenous variables and are not the target of prediction in the predictive relevance test.

**SRMR Test**

The Standardized Root Mean Square Residual (SRMR) is used to assess the difference between the observed correlation matrix and the estimated correlation matrix. An SRMR value ≤ 0.10 indicates an acceptable level of model fit (Hair et al., 2021).

**Table 8. SRMR Test Results**

|      | Saturated model | Estimated model |
|------|-----------------|-----------------|
| SRMR | 0.088           | 0.088           |

The evaluation results show an SRMR value of 0.088 for both the saturated model and the estimated model. This value is below the threshold of 0.10, indicating that the model demonstrates an acceptable level of fit.

**Effect Size (F-Square)**

The effect size (f-square) test is used to evaluate the magnitude of the contribution of each exogenous construct in explaining the variance of endogenous constructs in the structural model. The f-square value reflects the change in the coefficient of determination (R<sup>2</sup>) when an exogenous construct is removed from the model. In general, an f-square value below 0.02 indicates no meaningful effect, values between 0.02 and less than 0.15 indicate a small effect, values between 0.15 and less than 0.35 indicate a medium effect, and values of 0.35 or higher indicate a large effect.

**Table 9. Effect Size (F-Square) Results**

|   | f-square |
|---|----------|
| Workload_X1 → Needle Stick Injury_Y               | 0.027    |
| Workload_X1 → Risk Perception_M                   | 1.407    |
| Organizational Culture_X2 → Needle Stick Injury_Y | 0.000    |
| Organizational Culture_X2 → Risk Perception_M     | 0.015    |
| Risk Perception_M → Needle Stick Injury_Y         | 0.357    |

Based on Table 9, Workload has a small effect on Needle Stick Injury with an f-square value of 0.027. However, Workload shows a large effect on Risk Perception with an f-square value of 1.407. Organizational Culture does not show any effect on Needle Stick Injury (f-square = 0.000) and only demonstrates a very small effect on Risk Perception (f-square = 0.015). Meanwhile, Risk Perception shows a large effect on Needle Stick Injury with an f-square value of 0.357, indicating the substantial role of the mediating variable in explaining the variance of Needle Stick Injury.

**Hypothesis Testing**

**Direct Effect**

The significance of direct effects between constructs was evaluated based on t-statistics and p-values obtained through bootstrapping. Referring to PLS-SEM guidelines, a direct effect is considered significant if the t-statistic is greater than 1.96 or the p-value is less than 0.05 at a 5% significance level (two-tailed).

**Table 10. Direct Effect Results**

|  | Original sample (O) | Sample mean (M) | STDEV | T statistics | P values |
|--|---------------------|-----------------|-------|--------------|----------|
| Workload → Needle Stick Injury               | 0.169               | 0.171           | 0.130 | 1.301        | 0.193    |
| Workload → Risk Perception                   | 0.759               | 0.754           | 0.052 | 14.639       | 0.000    |
| Organizational Culture → Needle Stick Injury | -0.004              | 0.004           | 0.068 | 0.064        | 0.949    |

|  |        |        |       |       |       |
|--|--------|--------|-------|-------|-------|
| Organizational Culture → Risk Perception | -0.079 | -0.025 | 0.134 | 0.590 | 0.555 |
| Risk Perception → Needle Stick Injury    | 0.620  | 0.616  | 0.121 | 5.115 | 0.000 |

Based on the direct effect test results above, not all relationships between latent constructs show statistically significant effects. The relationship between Workload and Needle Stick Injury is not statistically significant ( $t = 1.301$ ;  $p = 0.193$ ). However, Workload has a significant positive effect on Risk Perception ( $t = 14.639$ ;  $p = 0.000$ ). Organizational Culture does not significantly affect Needle Stick Injury ( $t = 0.064$ ;  $p = 0.949$ ) nor Risk Perception ( $t = 0.590$ ;  $p = 0.555$ ). Meanwhile, Risk Perception has a significant positive effect on Needle Stick Injury ( $t = 5.115$ ;  $p = 0.000$ ).

### Indirect Effect

Indirect effect testing aims to assess the presence of a mediation mechanism in the relationship between exogenous and endogenous constructs. According to Hair et al. (2021), in PLS-SEM, the significance of indirect effects must be evaluated using the bootstrapping procedure because it provides more accurate inferential estimates without relying on normal distribution assumptions.

**Table 11. Indirect Effect Results**

|  | Original sample (O) | Sample mean (M) | STDEV | T statistics | P values |
|--|---------------------|-----------------|-------|--------------|----------|
| Workload → Risk Perception → Needle Stick Injury               | 0.471               | 0.465           | 0.100 | 4.719        | 0.000    |
| Organizational Culture → Risk Perception → Needle Stick Injury | -0.049              | -0.017          | 0.084 | 0.584        | 0.559    |

The indirect effect of Workload on Needle Stick Injury through Risk Perception is statistically significant ( $t = 4.719$ ;  $p = 0.000$ ). This indicates that Risk Perception functions as a mediating variable in the relationship between Workload and Needle Stick Injury. In contrast, the indirect effect of Organizational Culture on Needle Stick Injury through Risk Perception is not statistically significant ( $t = 0.584$ ;  $p = 0.559$ ). Therefore, Risk Perception does not mediate the relationship between Organizational Culture and Needle Stick Injury in the tested structural model.

## Discussion

### The Effect of Workload on Needle Stick Injury

The findings indicate that workload shows a positive directional relationship with needle stick injury, suggesting that higher work demands tend to be accompanied by a higher likelihood of injury. This direction is consistent with previous studies reporting that excessive workload increases the risk of sharp-object injuries among healthcare workers (Negash et al., 2024; Poku et al., 2025; Ketshabile, 2022; Hosseinabadi et al., 2019; Mengistu & Tolera, 2020; Bazie, 2020). High workload may reduce concentration, increase fatigue, and contribute to procedural errors. However, the direct relationship was not consistently supported, which aligns with findings from Mustapa et al. (2023) and Priyangani et al. (2017), who reported no significant association. From

the Swiss Cheese Theory perspective, occupational accidents result from multiple systemic failures rather than a single factor (Karimi et al., 2021). Thus, workload functions as one contributing condition within a broader safety system, and its effect depends on interaction with other defense layers.

#### **The Effect of Workload on Risk Perception**

Workload was found to positively influence risk perception, indicating that increased work demands heighten healthcare workers' awareness of occupational hazards. High task intensity and time pressure may increase psychological strain, making individuals more sensitive to potential risks in their environment. This finding is consistent with Oah et al. (2018), who reported that workload affects risk perception at both cognitive and emotional levels, and with Mao et al. (2025), who linked excessive workload to increased perceptions of occupational risk. Within the Swiss Cheese framework, workload represents a latent systemic condition that weakens safety defenses, prompting individuals to recognize greater vulnerability (Wiegmann et al., 2022). Therefore, the hypothesis that higher workload increases risk perception is supported.

#### **The Effect of Organizational Culture on Needle Stick Injury**

Organizational culture did not show a strong direct influence on needle stick injury. Although a more supportive culture theoretically contributes to safer practices, its direct impact was not evident in this model. Previous research has reported mixed findings. D'Etorre et al. (2020) showed that organizational interventions reduced injury incidents, while NOH et al. (2023) emphasized the role of safety-supportive practices in lowering accident rates. However, according to the Swiss Cheese Model, organizational culture operates as a latent systemic factor whose influence depends on interaction with supervision, workload, training, and risk control mechanisms (Wiegmann et al., 2022). Therefore, its impact may be indirect rather than immediate.

#### **The Effect of Organizational Culture on Risk Perception**

The findings indicate that organizational culture does not significantly shape risk perception in this context. Although culture theoretically influences how individuals interpret workplace hazards, its direct contribution to perceived risk was not clearly established. Within Reason's Accident Causation Theory and the Swiss Cheese Model, organizational culture is considered a latent failure embedded in the system (Wiegmann et al., 2022). Its influence on individual cognition depends on interaction with supervisory practices and operational conditions. Differences from prior studies, such as Abuzarqa (2019) and Tangsgaard (2021), suggest that the role of culture in shaping risk perception varies depending on systemic configurations. Safety outcomes, therefore, reflect the alignment of multiple defense layers rather than a single cultural factor.

#### **The Effect of Risk Perception on Needle Stick Injury**

Risk perception was found to influence needle stick injury in a positive direction. This indicates that higher levels of perceived risk were associated with higher injury occurrence, contrary to the assumption that risk perception functions purely as a protective factor. This finding is consistent with Isse et al. (2025), who identified risk perception as a predictor of needle stick injury. However, it contrasts with Mengistu et al. (2021), who found that lower risk perception was associated with higher injury rates. The variation suggests that risk perception may develop as a response to prior exposure or repeated incidents rather than solely as a preventive mechanism. According to the Swiss Cheese Model, accidents arise from systemic weaknesses rather than individual cognition alone (Wiegmann et al., 2022; Perneger, 2005).

High risk perception may reflect awareness formed after exposure to hazardous conditions. Thus, the direction of the relationship does not weaken the findings but highlights the complex interaction between experience, perception, and systemic vulnerability.

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### **The Effect of Workload on Needle Stick Injury Through Risk Perception**

The indirect analysis shows that risk perception mediates the relationship between workload and needle stick injury. Workload increases risk perception, and heightened risk perception is associated with injury occurrence, forming a significant mediation pathway. Even though the direction between risk perception and injury differs from the initial assumption, mediation analysis emphasizes the significance of the indirect effect rather than the direction of each partial path (Preacher & Hayes, 2004). In PLS-SEM, mediation is confirmed when the indirect pathway is supported through bootstrapping procedures. Within the Swiss Cheese framework, high workload acts as a latent condition that weakens safety defenses. Risk perception may emerge as a psychological response to increased exposure and systemic vulnerability. Thus, risk perception serves as a mechanism explaining how workload contributes to injury occurrence, although not strictly as a protective factor. Accordingly, the mediation hypothesis is supported.

### **The Effect of Organizational Culture on Needle Stick Injury Through Risk Perception**

The findings indicate that risk perception does not mediate the relationship between organizational culture and needle stick injury. The indirect pathway was not sufficiently supported, meaning that organizational culture does not translate into injury outcomes through changes in risk perception. Although theoretical frameworks position risk perception as a psychological mechanism linking organizational conditions and safety behavior, this mechanism was not empirically confirmed in this context. According to Reason's Accident Causation Theory and the Swiss Cheese Model, safety outcomes depend on interactions among multiple systemic layers rather than a single cultural or cognitive factor (Wiegmann et al., 2022). This finding reinforces the view that needle stick injury is a multicausal phenomenon influenced by structural, operational, and psychological elements simultaneously. Strengthening organizational culture alone may not be sufficient to reduce injury rates without comprehensive systemic interventions. Therefore, the final hypothesis regarding mediation is not supported.

## **5. Conclusion**

This study examined the relationships between workload, organizational culture, risk perception, and needle stick injury among healthcare workers in Denpasar City using a Partial Least Squares–Structural Equation Modeling approach. The findings demonstrate that workload and organizational culture do not directly influence needle stick injury. However, workload significantly increases risk perception, and risk perception is positively associated with injury occurrence. Furthermore, risk perception mediates the relationship between workload and needle stick injury, indicating that excessive work demands may indirectly contribute to injury through heightened exposure to perceived occupational risks. These results confirm that needle stick injury is not solely determined by organizational factors, but rather emerges from the interaction between operational pressures and psychological responses within healthcare safety systems.

Theoretically, this study contributes to the occupational safety literature by extending the application of Reason's Swiss Cheese Model and the Cultural Theory of Risk in explaining needle stick injury as a multicausal phenomenon. The study also highlights the important mediating role of risk perception in linking workload to occupational injury, thereby enriching existing research that has predominantly focused on direct organizational determinants.

Practically, the findings suggest that healthcare institutions should prioritize systemic workload management strategies, including adequate staffing, balanced scheduling, and clear task allocation, alongside strengthening operational safety practices such as supervision, reporting systems, safety training, and the provision of protective equipment. These interventions are essential to translate risk awareness into safer workplace behavior and reduce injury exposure.

Several limitations should be acknowledged. First, the cross-sectional design limits the ability to establish causal relationships and observe temporal changes in occupational risk dynamics. Second, the use of self-reported questionnaires may introduce response and perception bias, particularly in measuring risk perception and injury experiences. Third, the purposive sampling approach and the focus on healthcare workers in Denpasar City may restrict the generalizability of the findings to other healthcare settings or regions with different organizational characteristics. In addition, the model incorporated only one mediating variable and did not account for other potentially influential factors such as fatigue, burnout, safety compliance, and safety behavior.

Future research is recommended to employ longitudinal or mixed-method designs to better capture causal mechanisms and contextual dynamics of occupational injuries. Expanding the study across broader healthcare settings and incorporating additional behavioral and organizational variables would provide a more comprehensive understanding of needle stick injury prevention and healthcare worker safety.

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