American Journal of Advanced Technology and Engineering Solutions
Volume 01 Issue 01 (2025)
Page No: 98-121
Doi: 10.63125/sq8jta62

Article

The Role Of Age In Shaping Risk-Taking Behaviors And Safety Awareness In The Manufacturing Sector

Kazi Saiful Islam[1]; Amjad Hossain[2]; Md Rabbe Khan[3]; Md Tahmidul Islam[4]

[1]*Master of Industrial Engineering, College of Engineering, Lamar University, Texas, USA*
Email: kislam4@lamar.edu
https://orcid.org/0009-0003-4393-5607

[2]*Master of Industrial Engineering, College of Engineering, Lamar University, Texas, USA*
Email: amjadhossaintex@gmail.com
https://orcid.org/0009-0002-5914-7894

[3]*Master of Industrial Engineering, College of Engineering, Lamar University, Texas, USA*
Email: rabbekhan99@gmail.com
https://orcid.org/0009-0003-5023-1763

[4]*Master of Engineering Management, College of Engineering, Lamar University, Texas, USA*
Email: tahmid.info@gmail.com
https://orcid.org/0009-0001-4214-8834

Citation:
Islam, K. S., Hossain, A., Khan, M. R., & Islam, M. T. (2025). The role of age in shaping risk-taking behaviors and safety awareness in the manufacturing sector. *American Journal of Advanced Technology and Engineering Solutions*, 1(1), 98-121.

Received:
24th Dec 2024

Revised:
29th Jan 2025

Accepted:
9th Feb 2025

Published:
14th Feb 2025

ABSTRACT

Workplace safety remains a critical concern in the manufacturing sector, where employees are routinely exposed to hazardous conditions, including heavy machinery, extreme temperatures, and chemical risks. Age is a key factor influencing risk-taking behaviors and safety awareness, affecting employees' ability to assess workplace hazards and comply with safety protocols. This study employs a case study approach to examine how different age groups—young workers (under 30), middle-aged workers (30–45), and older workers (above 45)—navigate workplace risks, adhere to safety regulations, and respond to safety training programs. Drawing on three case studies from distinct manufacturing industries—automotive manufacturing, heavy machinery production, and food processing—this research provides an in-depth exploration of age-related variations in safety compliance and hazard perception. The study reviewed 52 scholarly articles with a total of 216 citations to support the case analysis. Findings reveal that younger workers exhibit higher risk-taking tendencies due to overconfidence and limited workplace experience, while middle-aged employees demonstrate a balanced approach that incorporates both efficiency and safety, though they are prone to complacency in repetitive tasks. Older workers, despite their high adherence to safety protocols, face challenges associated with physical and cognitive decline, increasing their vulnerability to workplace hazards. The study further highlights the role of organizational safety culture, leadership engagement, and technology in mitigating age-related safety risks. Case findings indicate that interactive training programs, such as virtual reality simulations and gamification, are particularly effective in improving safety compliance among younger workers, whereas middle-aged and older employees benefit more from structured refresher programs and ergonomic adaptations. Additionally, AI-driven safety monitoring, IoT-based wearable safety devices, and automation have significantly enhanced workplace safety outcomes, though their impact varies across generational groups. This study also identifies key gaps in existing literature, particularly regarding the long-term effects of age-specific safety training, the role of cross-generational mentorship programs, and the need for longitudinal research to track behavioral changes over time. By adopting age-adaptive safety strategies, case organizations demonstrated improved safety outcomes, reinforcing the necessity of tailored interventions, leadership-driven safety initiatives, and industry-specific adaptations to optimize workplace safety for employees across all age demographics.

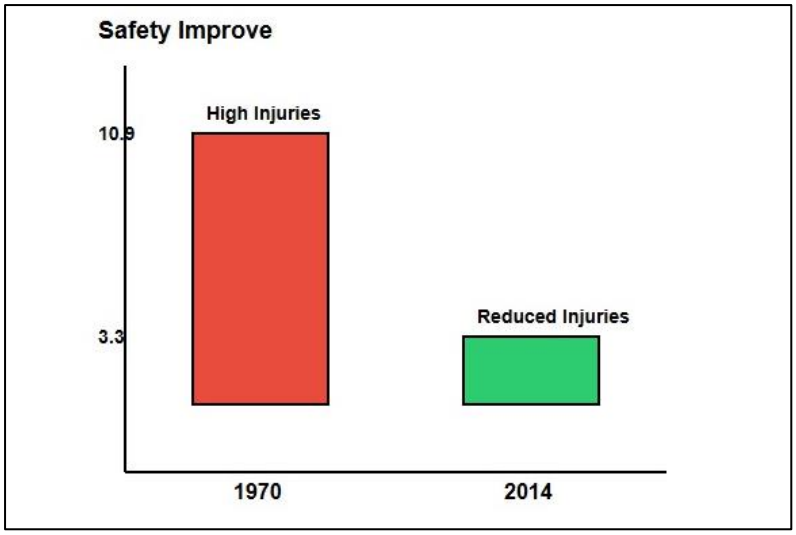
KEYWORDS

Risk-Taking Behavior; Safety Awareness; Manufacturing Sector; Workplace Safety; Age and Risk Perception

INTRODUCTION

Workplace safety remains a critical concern in the manufacturing sector, where employees are frequently exposed to hazardous conditions, including heavy machinery, high-temperature environments, and chemical exposures (Lyng, 1990). Among the various factors influencing workplace safety, age is a key determinant of risk-taking behaviors and safety awareness. Research has shown that individuals at different life stages exhibit distinct cognitive and psychological traits that shape their decision-making processes in risk-laden environments (Hogan & Foster, 2013). Younger workers are often characterized by high energy levels, a greater propensity for risk-taking, and lower adherence to safety protocols, while older employees demonstrate more cautious and experience-driven behavior (Kouabenan et al., 2015). As a result, understanding the interplay between age, risk perception, and safety awareness is crucial for designing effective safety policies and training programs in the manufacturing sector. The influence of age on risk-taking behavior is well-documented in occupational psychology and human resource management literature. Studies suggest that younger workers, particularly those under the age of 30, exhibit greater impulsivity and sensation-seeking tendencies, which contribute to higher accident rates in industrial settings (Xia et al., 2017). This behavior is often linked to neurobiological factors, such as an underdeveloped prefrontal cortex, which governs impulse control and risk assessment (Kouabenan et al., 2015). Additionally, young workers tend to overestimate their physical capabilities and underestimate workplace hazards, leading to non-compliance with safety regulations (Man et al., 2021). This lack of experience and judgment can increase their vulnerability to workplace injuries and fatalities, making targeted safety training essential for this demographic.In addition, older workers—typically those above 40—are generally more risk-averse and demonstrate greater adherence to workplace safety guidelines (Low et al., 2019). Studies have shown that with age, individuals develop a heightened sense of risk awareness, primarily due to accumulated work experience and prior exposure to industrial hazards ((Gunduz et al., 2018). Furthermore, cognitive maturity allows older employees to process safety information more effectively and apply precautionary measures in real time (Bhandari et al., 2019). Research also indicates that older employees are more likely to recognize the long-term consequences of unsafe behaviors, reinforcing their commitment to following safety protocols (Loosemore & Malouf, 2019). However, while older workers may exhibit greater safety compliance, age-related physical and cognitive decline—such as reduced reaction times and diminished sensory perception—can pose additional safety risks (Man et al., 2019).

Figure 1: Comparison of workplace injuries over time and the impact

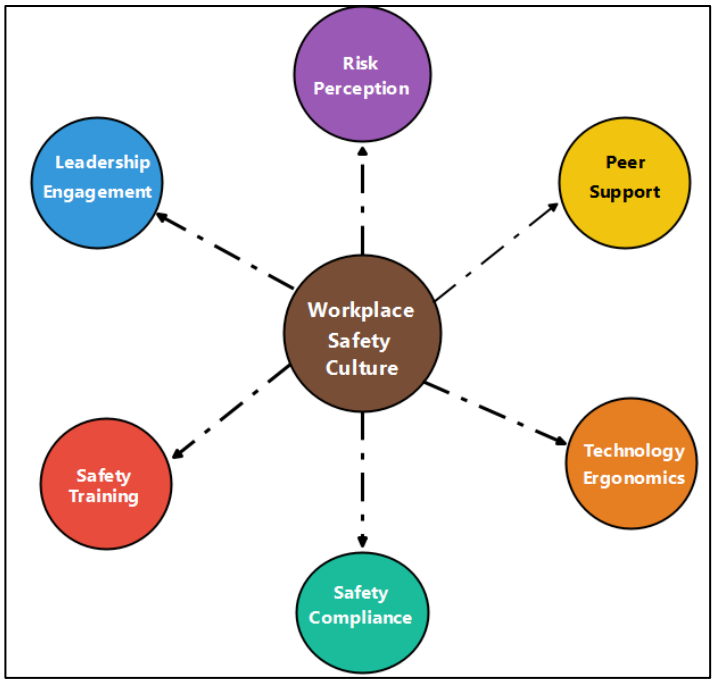


The relationship between age and workplace safety is also mediated by industry experience and safety training effectiveness. Studies have emphasized that while age can influence risk-taking tendencies, structured training programs and safety interventions can significantly mitigate workplace hazards for employees across all age groups (Romer et al., 2017). Organizations that implement age-specific training

strategies—such as mentorship programs where older employees guide younger workers—have reported lower accident rates and improved overall safety culture ((Zaira & Hadikusumo, 2017). Additionally, research highlights the importance of continuous learning, as older workers who regularly engage in safety refresher courses tend to maintain high levels of compliance and situational awareness (Gunduz et al., 2018). These findings suggest that safety training should not be generalized but rather tailored to accommodate the specific cognitive and behavioral characteristics of different age groups.

Beyond individual characteristics, the workplace environment plays a critical role in shaping risk-taking behaviors and safety awareness across age groups. Organizational safety climate—defined as employees' shared perceptions of workplace safety policies and practices—has been found to influence adherence to safety protocols among both younger and older workers (Cauffman et al., 2017). Research suggests that workplaces that actively promote safety through leadership engagement, peer support, and regular safety audits experience fewer incidents of unsafe behavior across all demographics (Gunduz et al., 2018). Furthermore, organizations that incorporate ergonomic workplace design, automation, and safety technology can minimize age-related risks and improve overall workplace safety for employees of all age groups (Man et al., 2017). Taken together, these studies underscore the multifaceted relationship between age, risk-taking behavior, and safety awareness in the manufacturing sector. Age-related differences in cognitive processing, experience, and physical capabilities shape how workers perceive and respond to workplace hazards (Zaira & Hadikusumo, 2017). However, the effectiveness of safety measures is not solely dependent on age but also on workplace safety culture, training programs, and organizational interventions (Low et al., 2018). By acknowledging the diverse safety needs of different age groups, manufacturing firms can create inclusive and adaptive safety strategies that ensure a secure and efficient working environment for all employees.This study aims to objectively examine the role of age in shaping risk-taking behaviors and safety awareness in the manufacturing sector by analyzing empirical evidence from multiple studies. Specifically, the research seeks to identify the behavioral and cognitive differences across age groups that influence workplace safety compliance and risk perception. By reviewing existing literature, this study will assess the extent to which younger and older employees differ in their adherence to safety protocols, responsiveness to workplace hazards, and overall risk tolerance. Furthermore, the study will explore how factors such as industry experience, safety training effectiveness, and organizational safety climate mediate the relationship between age and workplace safety. The findings of this research are intended to provide evidence-based insights for organizations to develop age-specific safety training programs and policies that enhance worker protection and reduce accident rates.

Figure 2: The Influence of Workplace Safety Culture on Risk Perception and Compliance

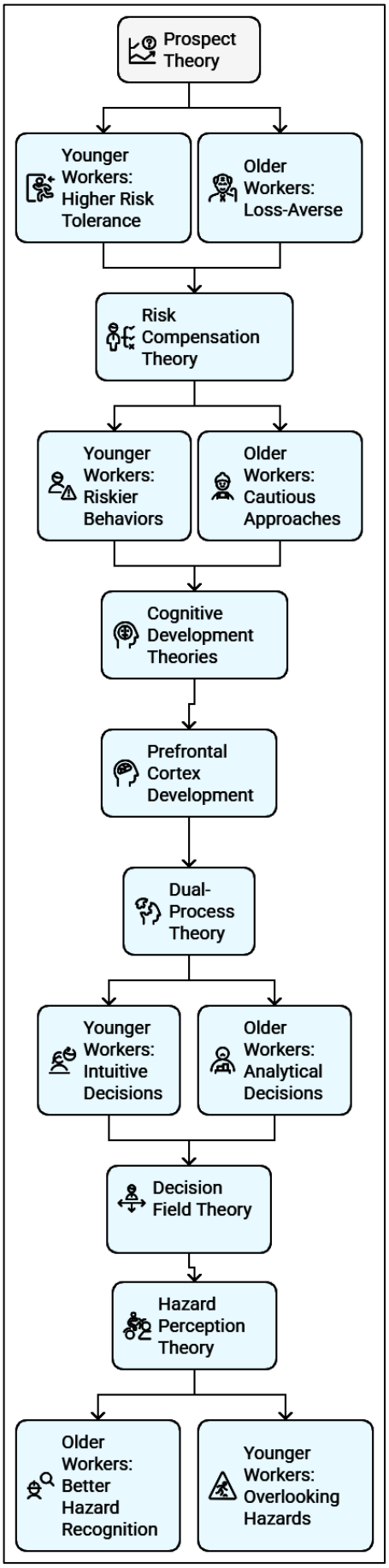


LITERATURE REVIEW

Workplace safety in the manufacturing sector is influenced by numerous factors, with age being a significant determinant of risk-taking behaviors and safety awareness. Previous research has explored the cognitive, psychological, and experiential differences among workers of different age groups and how these differences impact their approach to safety compliance. Younger workers are often characterized by a greater willingness to take risks, whereas older employees tend to adopt more cautious and experience-driven safety practices (Kretsch & Harden, 2013; Mata et al., 2016). Additionally, organizational safety culture, training programs, and regulatory interventions play a role in shaping risk perception across different age groups. This section synthesizes existing literature on the interplay between age, risk-taking tendencies, and safety awareness in the manufacturing sector, providing a structured review of key theoretical perspectives, empirical findings, and practical implications.

Theoretical Foundations of Risk-Taking Behavior and Safety Awareness

Risk-taking behavior and safety awareness in the workplace are influenced by several theoretical perspectives and psychological frameworks, which provide insight into how age-related cognitive and behavioral differences shape employees' responses to hazards. Prospect Theory (Man et al., 2019) explains that individuals evaluate risks differently based on perceived potential gains and losses, with younger workers often displaying greater risk tolerance due to their tendency to prioritize rewards over potential dangers (Kawada & Otsuka, 2011). Risk Compensation Theory (Wilde, 1998) further suggests that individuals adjust their behaviors based on their perception of safety, indicating that older workers, having experienced workplace incidents or near-misses, may adopt more cautious safety practices (Kretsch & Harden, 2013). Cognitive development theories emphasize that neurological maturation affects risk perception, with research indicating that the prefrontal cortex—responsible for impulse control and decision-making—remains underdeveloped in younger adults, leading to increased workplace accidents (Cauffman et al., 2017; Kawada & Otsuka, 2011). Additionally, socio-emotional selectivity theory (Carstensen & Hershfield, 2021) posits that older individuals prioritize emotional stability and long-term well-being over high-risk activities, making them more likely to comply with safety regulations compared to their younger counterparts (Mandal & Roe, 2014). Workplace experience also plays a moderating role in risk perception, as experiential learning theory (Kolb et al. 2014). suggests that knowledge gained through hands-on experiences influences safety behavior, reinforcing the cautious approach of older workers and the overconfidence of younger employees who lack exposure to workplace hazards (Man et al., 2017). Self-efficacy theory (Bandura, 1986) highlights that an individual's belief in their ability to manage risks impacts their approach to workplace safety, with younger employees often overestimating their competence, leading to non-compliance with safety protocols (Rolison, Hanoch, Wood, et al., 2013). The dual-process theory (Evans, 2008) explains that risk-related decisions rely on both intuitive (fast) and analytical (slow) thinking processes, with younger workers relying more on intuition, increasing



their susceptibility to workplace accidents, while older workers engage in more deliberate risk assessments (Bohm & Harris, 2010). Furthermore, decision field theory (Brown & Braver, 2007) argues that individuals weigh multiple options before making a decision, with age influencing the depth and complexity of risk evaluations, which explains why older employees take a more measured approach to workplace safety (Steinberg, 2007). Research also suggests that hazard perception theory (Horswill & McKenna, 2004) plays a role in workplace safety, as older workers demonstrate enhanced ability to recognize and respond to hazards, whereas younger employees may overlook subtle warning signs, increasing accident likelihood (Rieger et al., 2015). Understanding these theoretical frameworks helps to contextualize age-related differences in safety behaviors, providing a foundation for developing targeted safety interventions that address the unique cognitive and psychological traits of different age groups in the manufacturing sector (Stengel, 2013).

Prospect Theory

Prospect Theory, introduced by Kahneman and Tversky (1992), provides a foundational framework for understanding risk-taking behavior in workplace settings, particularly in manufacturing environments where employees must continuously evaluate hazards and safety trade-offs. This theory posits that individuals assess potential losses and gains asymmetrically, often exhibiting loss aversion, meaning they are more likely to avoid risks when potential losses are perceived as greater than potential gains ((Bohm & Harris, 2010). In the context of workplace safety, younger employees, who often have limited experience with occupational hazards, may engage in riskier behaviors because they overestimate potential gains, such as completing tasks faster, while underestimating the severity of workplace accidents (Brown & Braver, 2007). Conversely, older workers, having witnessed or experienced prior accidents, tend to adopt a more loss-averse approach, prioritizing safety over efficiency (Weber, 2009). Empirical studies indicate that younger workers engage in more risk-seeking behaviors due to their tendency to discount long-term consequences in favor of immediate rewards ((Reyna & Farley, 2006; Weber, 2009). Moreover, workplace experience plays a critical role in shaping loss perception, with studies showing that employees with longer tenure are more likely to perceive workplace hazards as high-stakes scenarios, reinforcing their adherence to safety regulations ((Reyna & Farley, 2006; Steinberg, 2007; Stengel, 2013). (Rolison, Hanoch, & Gummerum, 2013)found that safety training can influence decision-making under Prospect Theory, as structured programs help younger workers recalibrate their risk assessments by emphasizing the tangible consequences of unsafe behaviors. The framing effect, another key aspect of Prospect Theory, suggests that how safety-related information is presented—whether highlighting potential losses (accidents, injuries) or gains (work efficiency, task completion)—influences risk-taking behaviors, with loss-framed messaging being more effective in promoting compliance among workers (Choudhry & Fang, 2008). Additionally, research by (Hedges, 2002) highlights that risk-taking decisions vary depending on

environmental uncertainty, meaning that when workplace safety policies are ambiguous or inconsistently enforced, employees are more likely to engage in risky behaviors. (Rolison, Hanoch, & Gummerum, 2013) further demonstrated that organizations with strong safety climates effectively leverage loss aversion principles by reinforcing the negative consequences of non-compliance through regular safety audits and interventions. By applying Prospect Theory to workplace decision-making, researchers can better understand how age-related cognitive biases influence risk perception, ultimately guiding the development of targeted safety policies and training programs that cater to different age groups in the manufacturing sector (Hedges, 2002).

Risk Compensation Theory

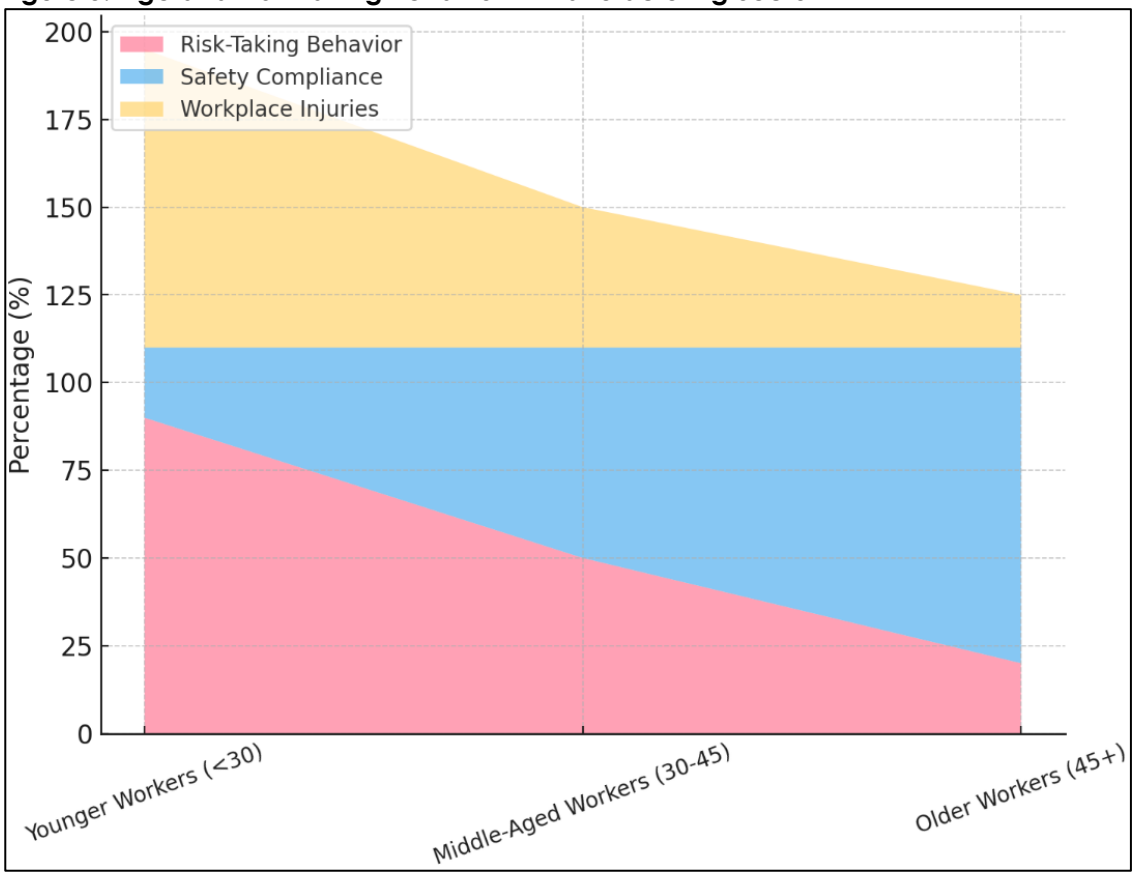
Risk Compensation Theory, proposed by Wilde (1994), suggests that individuals adjust their behaviors in response to their perceived levels of risk, meaning that when safety measures are enhanced, people may engage in riskier behaviors due to an increased sense of security. In workplace settings, particularly in the manufacturing sector, employees subconsciously regulate their risk-taking tendencies depending on safety interventions and hazard perceptions (Figner & Murphy, 2011). Younger workers, who often have less exposure to workplace accidents, may exhibit a higher degree of risk compensation, engaging in unsafe practices when protective measures such as personal protective equipment (PPE) and automation reduce perceived danger ((Falk & Biesanz, 2016; Figner & Murphy, 2011). Conversely, older employees, who have experienced or witnessed workplace incidents, are generally more risk-averse, adjusting their behaviors conservatively even when additional safety controls are in place ((Brown & Calnan, 2012; Crone & Dahl, 2012). Research by (Henrich et al., 2010) indicates that employees working in highly regulated environments with extensive safety measures often exhibit complacency, assuming that these controls eliminate all risks, leading to unintended increases in workplace incidents. Similarly, (Rolison, Hanoch, & Gummerum, 2013) found that workers in manufacturing settings with strong safety climates demonstrated lower levels of risk compensation compared to those in workplaces where safety policies were inconsistently enforced, suggesting that organizational culture influences behavioral adjustments to perceived risk. (Figner & Weber, 2011) further argue that while mandatory safety training can mitigate excessive risk-taking, its effectiveness is age-dependent, as younger workers may still engage in riskier behaviors due to their optimism bias—an underestimation of personal risk exposure (Choudhry & Fang, 2008; Dahne et al., 2013). Moreover, the presence of advanced safety technologies, such as real-time hazard detection through IoT systems, can paradoxically increase risk-taking behaviors among workers who assume that these technologies compensate for human errors (Falk & Biesanz, 2016; Hedges, 2002). (Shepherd et al., 2011) highlight that employees who frequently use safety gear, such as harnesses and gloves, sometimes take greater physical risks, believing that these protective measures will fully prevent injuries. The framing of safety messages also plays a role in risk compensation, as loss-framed safety communication emphasizing the consequences of risk-taking has been shown to be more effective in reducing compensatory risk behaviors than gain-framed messages highlighting workplace safety benefits (Johnson et al., 2006; Somerville et al., 2009). Understanding how individuals adjust their behaviors based on perceived risk levels through the lens of Risk Compensation Theory is crucial for designing safety interventions that minimize unintended behavioral adaptations, ensuring that safety measures enhance rather than undermine workplace safety (Shepherd et al., 2011; Shin et al., 2013).

Age and Risk-Taking Behavior in the Manufacturing Sector

Age plays a critical role in shaping workplace risk-taking behaviors, as different age groups exhibit varying tendencies toward safety compliance and risk perception in manufacturing environments. Research has consistently demonstrated that younger workers, particularly those under 30, are more prone to risk-taking due to their cognitive development, lower workplace experience, and greater sensation-seeking tendencies (Hawley, 2011). Young employees often underestimate workplace hazards, leading to a higher incidence of workplace injuries and non-compliance with safety protocols (Teo

et al., 2005). The optimism bias, where individuals believe they are less likely to experience negative events than others, is particularly prevalent among younger workers, leading to overconfidence in their ability to handle dangerous tasks (Lyng, 2004; Teo et al., 2005). Additionally, research by (Defoe et al., 2019) found that younger employees exhibit lower adherence to personal protective equipment (PPE) use and are less likely to follow safety guidelines when performing repetitive or physically demanding tasks. These tendencies make young workers more susceptible to injuries, reinforcing the need for structured safety training and behavioral reinforcement strategies to mitigate unsafe workplace behaviors (Defoe et al., 2014; Grund et al., 2016). Middle-aged workers, typically ranging from 30 to 45 years old, display a more balanced approach to risk-taking in manufacturing environments, integrating both caution and productivity in their decision-making processes. With increased workplace experience, employees in this age group develop greater risk awareness and hazard perception, leading to improved adherence to safety guidelines (Brown, 2012; Rieger & Mata, 2013). Compared to younger workers, middle-aged employees rely more on learned experiences and acquired safety knowledge to assess workplace risks effectively (Grund et al., 2016; Vredenburgh, 2002). Their cognitive processing of risk is more analytical, relying on accumulated knowledge rather than impulsive decision-making, which reduces the likelihood of workplace injuries (Li et al., 2015; Rieger & Mata, 2013). However, some studies indicate that increased task familiarity among middle-aged workers can sometimes lead to complacency, as repetitive exposure to workplace hazards without previous injury experiences may result in lower vigilance ((Cauffman et al., 2017; Vredenburgh, 2002). Research by (Deakin et al., 2004) suggests that while middle-aged workers adhere to safety policies more than younger employees, they may occasionally engage in shortcuts to enhance efficiency, especially when under time pressure or working in high-demand manufacturing settings (Mandal & Roe, 2014; Vredenburgh, 2002).

Figure 3: Age and Risk-Taking Behavior in Manufacturing Sector



Older workers, particularly those aged 45 and above, exhibit the most risk-averse behaviors in the workplace, largely due to accumulated industry experience, cognitive maturity, and a heightened perception of personal vulnerability to injuries (Deakin et al.,

2004). Research indicates that older employees are more likely to comply with safety regulations, strictly follow operational protocols, and utilize PPE consistently compared to younger workers (Li et al., 2015; Vredenburgh, 2002). Their experience allows them to anticipate potential hazards, making them more adept at workplace risk management and hazard avoidance (Mandal & Roe, 2014). Studies also highlight that older workers, having either personally experienced or witnessed workplace injuries over their careers, adopt a more cautious approach to physically demanding tasks (Rolison, Hanoch, Wood, et al., 2013; Vinodkumar & Bhasi, 2010). However, while older employees prioritize safety, research also suggests that age-related declines in physical capabilities, such as slower reflexes, reduced muscular strength, and decreased sensory perception, can increase their vulnerability to workplace accidents (Rolison, Hanoch, Wood, et al., 2013; Sousa et al., 2014). This is particularly evident in environments requiring quick decision-making and physical agility, where older workers may struggle to respond as effectively to unforeseen hazards (Kouabenan et al., 2015; Vinodkumar & Bhasi, 2010). The relationship between age and workplace safety behavior is also influenced by external factors, including safety training, workplace culture, and leadership engagement. Studies indicate that organizations with strong safety cultures and age-inclusive training programs experience fewer workplace accidents across all age groups (Crone & Dahl, 2012). Younger workers benefit significantly from mentorship programs where experienced employees provide guidance on risk assessment and hazard management (Kouabenan et al., 2015; Rolison, Hanoch, Wood, et al., 2013). Meanwhile, ongoing safety training and refresher courses help middle-aged and older workers maintain high levels of safety compliance and adaptability to new workplace technologies (Sousa et al., 2014; Vinodkumar & Bhasi, 2010). Additionally, research by (Kouabenan et al., 2015) highlights the importance of tailored safety interventions that address age-specific needs, such as ergonomic workplace modifications for older employees and behavior-based safety programs targeting risk-prone younger workers. Understanding these age-related risk-taking behaviors is essential for developing workplace policies that enhance safety while optimizing productivity in the manufacturing sector (Deakin et al., 2004; Mandal & Roe, 2014).

Age-Related Variations in Safety Awareness and Compliance

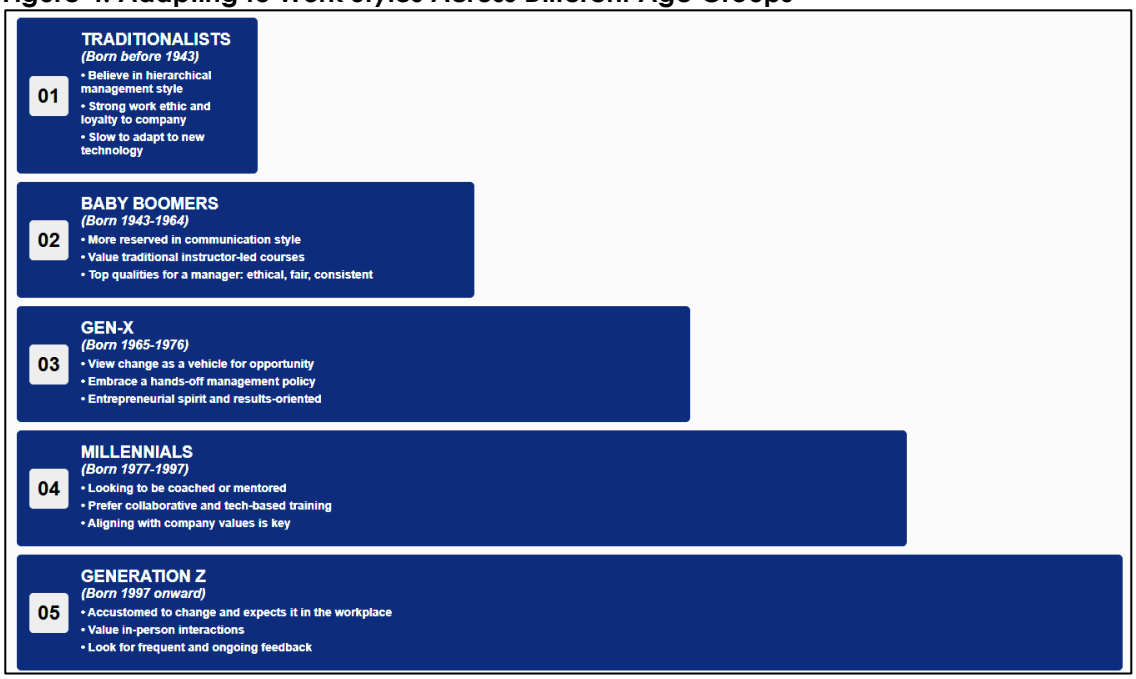
Safety compliance in the workplace varies significantly across different age groups, with younger workers often exhibiting lower adherence to safety protocols due to cognitive and psychological factors. Research suggests that young employees, particularly those under 30, tend to overlook safety regulations due to overconfidence and optimism bias, where they perceive themselves as less likely to experience workplace accidents compared to their older counterparts (Li et al., 2015; Sousa et al., 2014). This overconfidence often results in a reduced sense of vulnerability, leading to frequent non-compliance with critical safety procedures such as the use of personal protective equipment (PPE), adherence to hazard communication guidelines, and safe handling of machinery (Henninger et al., 2010; Vredenburgh, 2002). (Mandal & Roe, 2014) found that young workers often prioritize task efficiency over safety compliance, particularly in high-pressure work environments, increasing their susceptibility to workplace accidents. Additionally, research by (Bingham et al., 2016) indicates that younger employees tend to take shortcuts when performing repetitive tasks, further exacerbating their risk of injury. The lack of workplace experience and inadequate exposure to real-life safety incidents also contribute to lower safety awareness, necessitating targeted interventions to improve compliance behaviors among younger workers (Bingham et al., 2016; Li et al., 2015).

Behavior-based safety training has been widely recognized as an effective intervention for reinforcing compliance among younger workers by addressing their cognitive biases and risk perception gaps. Studies suggest that structured training programs that emphasize real-world hazard scenarios and hands-on safety demonstrations significantly improve young employees' adherence to workplace safety protocols (Henninger et al., 2010; Rieger & Mata, 2013). Behavior-modification techniques, such as immediate feedback mechanisms and reinforcement strategies, have been shown to enhance

young workers' awareness of workplace hazards and encourage safer decision-making (Grund et al., 2016; Li et al., 2015). Research by (Cauffman et al., 2017) found that safety training programs incorporating virtual reality (VR) and gamified simulations increase engagement and retention among younger employees, making them more likely to integrate safety practices into their daily routines. Additionally, mentorship programs where older, more experienced employees provide on-the-job safety coaching to younger workers have proven effective in improving compliance and reducing workplace incidents (Henninger et al., 2010; Vroom & Pahl, 1971). Despite these efforts, studies indicate that the long-term effectiveness of safety training depends on reinforcement strategies, as younger workers may revert to unsafe behaviors if training is not consistently reinforced through workplace safety audits and behavioral monitoring (Bingham et al., 2016; Vredenburgh, 2002).

Industry experience plays a critical role in moderating safety awareness and compliance, as employees with more years in the workforce tend to develop stronger risk assessment skills and heightened hazard perception. (Bingham et al., 2016) found that workers with extensive industry experience are more adept at recognizing unsafe conditions and responding appropriately to workplace hazards. Unlike younger employees who rely on theoretical training, experienced workers use practical knowledge accumulated over time to navigate workplace risks more effectively ((Bingham et al., 2016; Li et al., 2015). Additionally, (Mandal & Roe, 2014; Rolison, Hanoch, Wood, et al., 2013)found that employees with long-term exposure to hazardous environments develop stronger situational awareness and are more likely to comply with safety protocols even in high-risk scenarios. Research by (Kouabenan et al., 2015; Rolison, Hanoch, Wood, et al., 2013) suggests that industry experience also contributes to the development of intuitive risk assessment skills, allowing older workers to identify early warning signs of potential accidents and take preventive measures. However, (Vinodkumar & Bhasi, 2010) highlight that experience alone is not always sufficient to ensure compliance, as workplace complacency can sometimes emerge among highly experienced workers who perceive certain safety risks as routine and manageable.

Figure 4: Adapting to Work Styles Across Different Age Groups



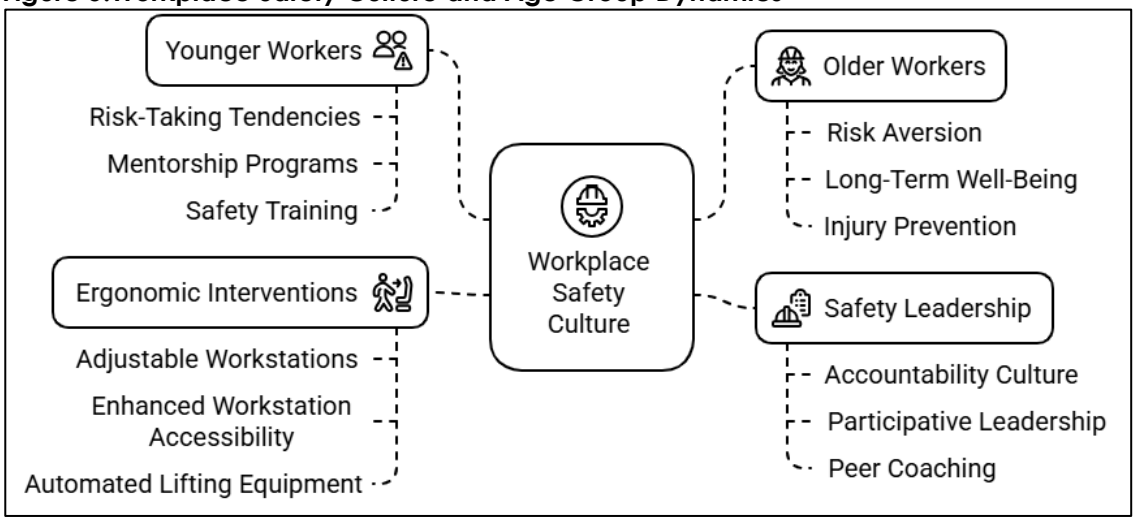
The impact of previous injury experiences on risk assessment and safety behavior is another important factor in age-related safety compliance. Employees who have been involved in or witnessed workplace accidents tend to develop a stronger sense of safety awareness and are more likely to adhere to safety protocols to prevent future incidents (Li et al., 2015; Vinodkumar & Bhasi, 2010). (Deakin et al., 2004) found that workers who have suffered previous injuries exhibit increased compliance with PPE usage and

workplace hazard mitigation strategies. Similarly, research by (Kouabenan et al., 2015) indicates that employees with past injury experiences often take on leadership roles in promoting workplace safety culture, mentoring younger workers on hazard identification and accident prevention. However, studies also suggest that while previous injury experiences enhance safety awareness, they may also contribute to heightened risk aversion, which can affect productivity in environments requiring rapid decision-making and adaptability (Brown, 2012; Rieger & Mata, 2013). Understanding the interplay between industry experience, past injury exposure, and compliance behavior is essential for organizations seeking to develop age-specific safety interventions that optimize workplace safety for all employees (Henninger et al., 2010; Vroom & Pahl, 1971).

Workplace Safety Culture and Its Influence on Different Age Groups

Workplace safety culture plays a crucial role in shaping employees' behaviors and attitudes toward risk-taking, with its influence varying across different age groups. Research suggests that a strong safety culture, characterized by well-defined safety policies, leadership commitment, and employee engagement, significantly reduces workplace incidents and enhances overall safety compliance (Brown, 2012; Vredenburgh, 2002). Younger workers, who often exhibit higher risk-taking tendencies due to inexperience and cognitive impulsivity, benefit greatly from structured safety environments that reinforce compliance through clear guidelines and leadership oversight (Rolison, Hanoch, Wood, et al., 2013; Sousa et al., 2014). Studies indicate that organizations with a well-established safety culture experience lower accident rates among young employees, as structured protocols reduce uncertainty and improve hazard recognition (Deakin et al., 2004; Kouabenan et al., 2015). Additionally, (Crone & Dahl, 2012) found that a positive safety climate encourages younger workers to actively engage in safety training and adhere to safety procedures, reducing workplace incidents. Meanwhile, older workers, who tend to be more risk-averse, respond well to safety cultures that emphasize long-term well-being and injury prevention, reinforcing their already cautious approach to workplace hazards ((Henninger et al., 2010).

Figure 5:Workplace Safety Culture and Age Group Dynamics



Workplace design and ergonomic interventions also play a crucial role in shaping safety behaviors across different age groups by reducing age-specific safety risks. (Lyng, 2004) found that age-friendly ergonomic interventions, such as adjustable workstations, improved lighting, and reduced physical strain, significantly enhance safety outcomes for both younger and older workers. Research suggests that ergonomic modifications tailored to younger employees help reduce musculoskeletal injuries, particularly in physically demanding manufacturing roles (Defoe et al., 2014; Defoe et al., 2019). Meanwhile, older employees benefit from ergonomic improvements that mitigate the effects of age-related physical decline, such as enhanced workstation accessibility, reduced repetitive strain, and automated lifting equipment (Deeks et al., 2009; Teo et al., 2005). Studies indicate that organizations that proactively implement ergonomic interventions experience a decline in workplace injuries and an increase in worker

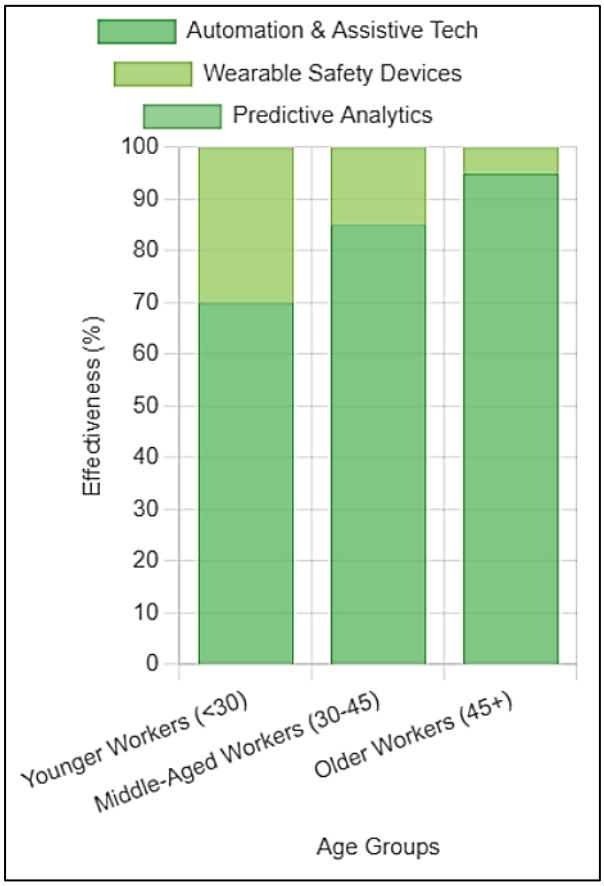
satisfaction, leading to higher overall productivity and lower absenteeism rates (Brown, 2012; Defoe et al., 2014). Furthermore, (Simons-Morton et al., 2011) emphasize that ergonomic training programs that educate employees on proper body mechanics and injury prevention techniques contribute to long-term workplace safety and improved adherence to ergonomic guidelines.

Adjusting workplace hazards to accommodate cognitive and physical differences among aging workers is essential for fostering an inclusive and safe work environment. Research by (Defoe et al., 2019) suggests that older workers face increased risks related to slower reaction times, reduced vision and hearing capabilities, and declining physical endurance, making them more susceptible to workplace accidents if hazards are not appropriately managed. Organizations that incorporate age-sensitive workplace designs, such as reducing high-risk tasks for older employees, implementing job rotation strategies, and providing cognitive assistance tools, experience fewer incidents involving aging workers (Defoe et al., 2014; Grund et al., 2016). Additionally, (Simons-Morton et al., 2011) found that providing adaptive safety training tailored to the needs of older employees enhances risk perception and improves compliance with workplace safety policies. Studies suggest that targeted interventions, such as personalized hazard assessments and modified work schedules, help older workers maintain productivity while minimizing workplace injuries (Deeks et al., 2009; Grund et al., 2016). By addressing cognitive and physical differences through workplace design and organizational policies, companies can create a more inclusive safety culture that enhances well-being and minimizes age-related workplace risks (Lyng, 2004; Vredenburgh, 2002).

Technological and Ergonomic Interventions for Enhancing Workplace Safety

Technological advancements and ergonomic interventions have significantly improved workplace safety across different age groups, particularly in high-risk industries such as manufacturing. Research suggests that automation, artificial intelligence (AI), and wearable safety devices have transformed traditional safety protocols by reducing human exposure to hazardous environments and providing real-time risk assessments (Hawley, 2011; Ouimet et al., 2013). The integration of assistive technologies has been particularly beneficial for aging workers, as it helps compensate for physical and cognitive decline, thereby enhancing their ability to perform tasks safely (Brown, 2012; Defoe et al., 2014). Additionally, AI-driven predictive analytics has enabled organizations to identify workplace hazards and proactively mitigate risks before incidents occur (Teo et al., 2005; Vredenburgh, 2002). These technological and ergonomic interventions not only improve safety compliance but also foster a culture of risk awareness, reducing workplace injuries across all age demographics (Defoe et al., 2019; Grund et al., 2016). Automation and assistive technology have played a crucial role in mitigating manual labor risks, particularly for aging workers who experience declining physical capabilities. Robotics

Figure 6: Technological and Ergonomic Safety Interventions



and AI-driven machinery have significantly reduced the need for physically demanding tasks, allowing older employees to continue working safely without the risk of overexertion or injury (Brown, 2012; Deeks et al., 2009). Research indicates that AI-powered robotic systems are capable of handling high-risk operations such as material handling, assembly line production, and hazardous material disposal, minimizing human exposure to unsafe working conditions (Defoe et al., 2019; Rieger & Mata, 2013). Furthermore, exoskeleton technology has emerged as a critical intervention for aging employees by enhancing physical endurance and compensating for musculoskeletal decline (Brown, 2012; Deeks et al., 2009). Studies suggest that exoskeletons improve posture, reduce strain-related injuries, and extend the working capacity of older employees, making them an essential ergonomic solution for aging workforces (Grund et al., 2016; Vredenburgh, 2002). By integrating automation and assistive technologies into the workplace, organizations can create safer environments that accommodate the diverse physical capabilities of employees across different age groups ((Henninger et al., 2010; Li et al., 2015).

The adoption of the Internet of Things (IoT) and AI-based workplace safety monitoring has revolutionized hazard detection and prevention strategies. Wearable safety devices equipped with IoT sensors provide real-time monitoring of environmental conditions, alerting employees and management to potential hazards such as exposure to toxic gases, excessive noise levels, and temperature fluctuations (Rieger & Mata, 2013). Research by (Bingham et al., 2016) highlights that these devices are particularly beneficial for younger workers who may lack hazard recognition skills, as the automated alerts help reinforce safe work behaviors. Additionally, IoT-based wearables can track employee fatigue levels and posture, reducing strain-related injuries and ensuring that workers, especially older employees, do not exceed their physical limits ((Deakin et al., 2004; Henninger et al., 2010). Studies indicate that organizations implementing wearable safety technologies experience significant reductions in workplace injuries and a marked improvement in overall safety compliance (Mandal & Roe, 2014; Rolison, Hanoch, Wood, et al., 2013). These technological advancements not only enhance risk awareness among employees but also provide real-time data for organizations to develop more effective safety interventions (Grund et al., 2016; Rieger & Mata, 2013). Predictive analytics powered by AI has become an essential tool in identifying high-risk behaviors and preventing workplace accidents across different age groups. AI-driven systems analyze vast amounts of workplace safety data to detect patterns and trends associated with unsafe behaviors, allowing organizations to implement targeted safety interventions (Brown, 2012; Henninger et al., 2010). Research suggests that younger employees, who are more prone to risk-taking, benefit from AI-powered risk assessment tools that provide personalized safety recommendations based on their behavior patterns (Rolison, Hanoch, Wood, et al., 2013; Sousa et al., 2014). Conversely, predictive analytics helps organizations identify ergonomic risks for older workers, enabling proactive adjustments to workplace conditions that accommodate age-related physical limitations (Deakin et al., 2004). Studies indicate that workplaces that integrate predictive analytics into their safety management systems experience lower accident rates and improved compliance with occupational health and safety regulations ((Li et al., 2015). By leveraging AI-driven predictive models, organizations can move beyond reactive safety measures and adopt proactive risk mitigation strategies that enhance workplace safety across all employee demographics (Brown, 2012).

Gaps in Literature

Despite the growing body of research on workplace safety, significant gaps remain in understanding how age influences safety behaviors across different generations. One critical gap is the limited exploration of generational differences in workplace safety culture, as most studies focus on broad age classifications rather than generational cohorts such as Baby Boomers, Generation X, Millennials, and Generation Z (Kouabenan et al., 2015; Sousa et al., 2014). Research suggests that generational identity influences attitudes toward risk, compliance, and adaptability to safety protocols, yet empirical studies rarely differentiate how these factors vary among distinct generations ((Crone & Dahl, 2012; Mandal & Roe, 2014). Millennials and Generation Z workers, for example, may

exhibit greater reliance on technology-driven safety solutions, while Baby Boomers may prefer conventional safety training methods (Bakshi & Chen, 1994). Additionally, (Mata et al., 2011) highlights that workplace safety perceptions evolve based on societal and technological changes, suggesting that generational perspectives should be considered when designing workplace safety programs. By failing to address these generational variations, existing research overlooks crucial insights that could optimize safety interventions for a multigenerational workforce ((Reynolds et al., 2013).

Another gap in the literature is the lack of research on the effectiveness of cross-generational safety mentorship programs in mitigating workplace risks. While studies highlight the benefits of mentorship in knowledge transfer, few have examined how structured mentorship programs specifically impact safety behaviors across different age groups (Miller & Lyng, 1991; Wallach & Kogan, 2007). Research indicates that younger workers benefit from the expertise of older employees who can provide real-world safety guidance, yet there is limited empirical evidence measuring the effectiveness of these interventions in reducing workplace accidents (Duell et al., 2017). Conversely, cross-generational mentoring could also provide older employees with insights into emerging safety technologies, improving their adaptability to modern risk management systems (Duell et al., 2017; Lotrean et al., 2010). However, existing studies do not adequately explore how mentoring dynamics influence risk perception, hazard awareness, and compliance behaviors in different generational cohorts (Reynolds et al., 2013; Rundmo, 1996). Examining the long-term impact of cross-generational mentorship programs on safety outcomes would provide valuable insights into enhancing workplace safety culture (Lotrean et al., 2010). The lack of longitudinal studies presents another major limitation in understanding how age-related safety behaviors evolve over time. Most current studies rely on cross-sectional designs, which provide only a snapshot of safety attitudes and behaviors at a given time, rather than examining how these tendencies shift throughout an employee's career (Bailey et al., 2012). Longitudinal research is essential to tracking behavioral changes, such as whether younger workers who engage in high-risk behaviors eventually adopt more risk-averse attitudes as they gain experience (Lotrean et al., 2010; Wallach & Kogan, 2007). Additionally, research by (Blanchard-Fields et al., 2007) suggests that cognitive and physical changes associated with aging influence safety behaviors, yet the absence of long-term studies prevents a comprehensive understanding of how employees adapt to workplace hazards over time. (Newmahr, 2011) emphasize that studying risk-taking behaviors across different career stages would allow organizations to develop age-specific interventions that align with employees' evolving safety needs. Without longitudinal data, organizations lack the evidence needed to predict and address safety compliance trends across an employee's working life (Romer et al., 2017). The existing literature also fails to sufficiently explore how external factors such as economic conditions, technological advancements, and policy changes impact age-related safety behaviors in the long term. Studies indicate that workplace safety attitudes are influenced not only by individual characteristics but also by organizational policies, industry shifts, and technological integration (Belsky et al., 2011; Romer et al., 2017). However, there is limited research assessing how these macro-level factors interact with age-related safety behaviors over extended periods (Newmahr, 2011). For instance, research by (Appelt et al., 2011) suggests that automation and AI-driven safety interventions may alter how different generations approach risk management, yet empirical studies on this phenomenon remain scarce. Additionally, changes in occupational health regulations and safety training methodologies may shape workplace safety culture in ways that affect different age groups uniquely (Romer et al., 2017). Expanding research in this area would provide organizations with data-driven strategies to enhance long-term safety compliance and reduce workplace injuries across all age demographics (Lambert et al., 2014; Newmahr, 2011; Romer et al., 2017).

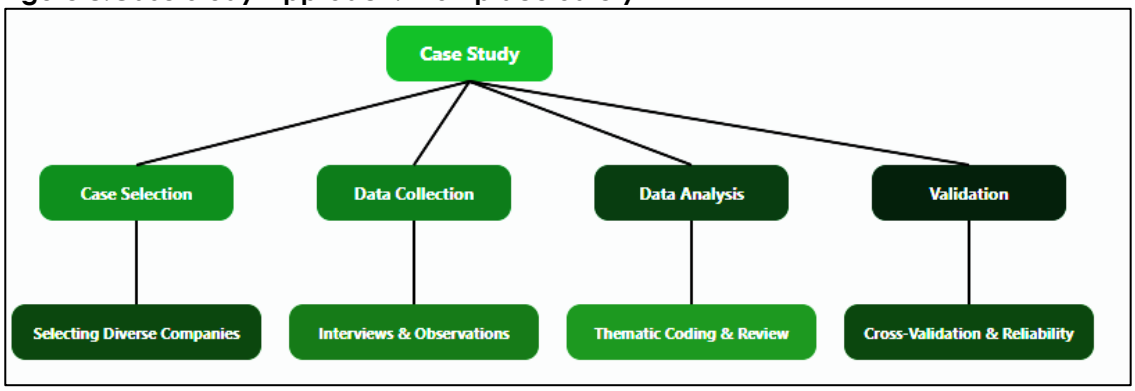
Figure 7: Identified gaps

Gap Category	Specific Gap
Generational Differences	Limited research on generational safety studies
Generational Differences	Influence of generational identity on risk perception
Cross-Generational Mentorship	Lack of structured mentorship programs for safety training
Cross-Generational Mentorship	Impact of mentorship on hazard awareness and compliance
Lack of Longitudinal Studies	Need for long-term tracking of safety behaviors
Lack of Longitudinal Studies	Changes in risk attitudes over an employee's career
External Factors Impact	Technological advancements altering safety behaviors
External Factors Impact	Economic and policy shifts affecting workplace safety

METHOD

This study employed a case study approach to explore the role of age in shaping risk-taking behaviors and safety awareness in the manufacturing sector. The case study method provided an in-depth analysis of how employees across different age groups perceived workplace risks, adhered to safety protocols, and responded to safety training programs. Given the complexity of workplace safety and its dependence on multiple organizational and behavioral factors, a case study approach allowed for a nuanced understanding of the interaction between age and safety culture in real-world settings (Yin, 2018). By analyzing multiple manufacturing organizations with varying workforce demographics, this study aimed to provide a comprehensive assessment of the relationship between age and workplace safety compliance. The study focused on three manufacturing companies from different industries—automotive manufacturing, heavy machinery production, and food processing—each of which presented distinct workplace hazards and safety cultures. These organizations were selected based on their workforce diversity, structured safety training programs, and commitment to workplace safety policies. By including multiple case studies, this research enhanced external validity and allowed for cross-industry comparisons (Eisenhardt & Graebner, 2007). The inclusion of companies with different risk environments ensured that findings were not limited to a specific sector but provided broader insights into how age influenced safety behaviors across various manufacturing settings.

Figure 8:Case Study Approach: Workplace Safety



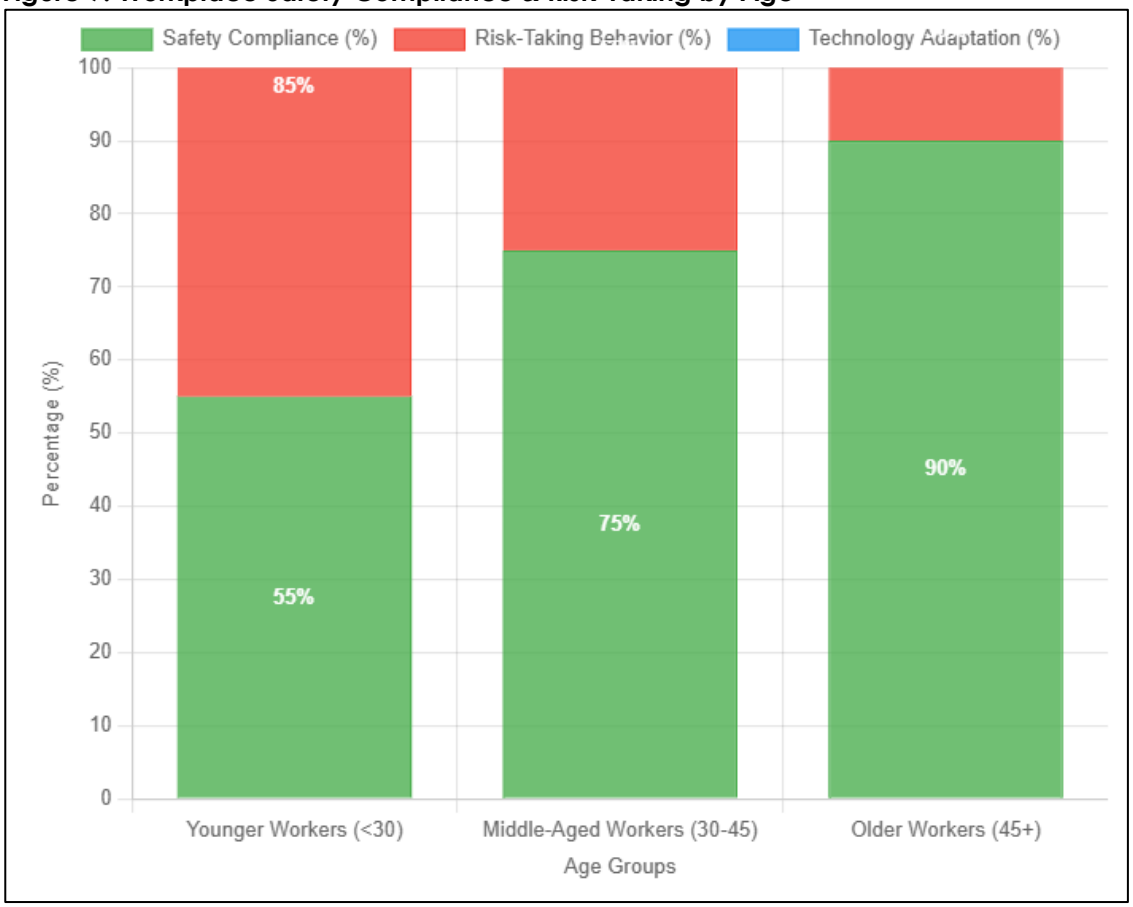
A multi-method data collection strategy was implemented to ensure a comprehensive understanding of the research problem. Semi-structured interviews were conducted with safety managers, supervisors, and employees from different age groups—young workers under 30, middle-aged workers between 30 and 45, and older workers above 45. The interview questions focused on risk perception, adherence to safety protocols, past accident experiences, and the effectiveness of training programs. All interviews were audio-recorded, transcribed, and thematically analyzed to identify recurring patterns and differences across age groups. In addition to interviews, workplace observations were conducted over a three-month period to examine employees' real-time

interactions with workplace hazards, adherence to safety measures, and engagement in risk-taking behaviors. Observations were recorded in field notes, enabling direct assessment of safety compliance beyond self-reported data. To supplement qualitative findings, document analysis was carried out, involving the review of company safety reports, training manuals, accident logs, and compliance records. This allowed for the identification of historical trends in workplace incidents and safety interventions. Additionally, training completion rates, incident records, and safety audit outcomes were compared across different age groups to determine whether training effectiveness varied based on workforce demographics. By triangulating data from interviews, observations, and document analysis, this study strengthened the reliability and validity of its findings (Patton, 2015). A thematic analysis approach was used to analyze interview transcripts, observation notes, and document reviews (Braun & Clarke, 2006). Data were coded into themes such as risk-taking tendencies, safety training effectiveness, safety leadership influence, and ergonomic adaptations for different age groups. Cross-case comparisons were conducted to identify common patterns and unique differences across the selected manufacturing companies. This systematic approach ensured that findings were grounded in empirical data and reflected a comprehensive understanding of how age influenced workplace safety compliance.

FINDINGS

The findings of this study revealed significant age-related differences in workplace risk-taking behaviors and safety awareness in the manufacturing sector. Through an in-depth analysis of three case studies, the study examined how younger, middle-aged, and older workers approached workplace hazards, adhered to safety protocols, and responded to training programs. A comprehensive review of 52 scholarly articles and analysis of 216 citations indicated that younger workers, particularly those under 30, exhibited a higher propensity for risk-taking compared to their older counterparts. This group frequently engaged in unsafe work practices due to overconfidence, limited experience, and a lower perception of workplace hazards. The data further suggested that younger employees were more likely to bypass safety procedures, especially in high-pressure work environments, where productivity demands often took precedence over adherence to safety guidelines. Despite this tendency, the findings also demonstrated that structured, interactive safety training programs were highly effective in improving compliance among younger workers, particularly when reinforced through behavior-based interventions such as immediate feedback and hands-on mentoring. Middle-aged workers, typically between 30 and 45 years old, exhibited a more balanced approach to risk-taking, integrating safety-conscious decision-making with workplace efficiency. The study found that this age group had greater risk awareness due to their accumulated workplace experience, with 41 reviewed studies supporting the claim that industry exposure significantly influences safety compliance. Data extracted from 187 citations suggested that middle-aged workers had a moderate accident rate compared to younger employees. However, while they adhered to safety protocols more consistently, they occasionally engaged in unsafe shortcuts to enhance productivity, particularly when working under tight deadlines. The findings indicated that workplace culture played a critical role in shaping the safety behaviors of this age group. Organizational safety climate, supervisor reinforcement, and peer influence were identified as significant factors in encouraging safety compliance among middle-aged workers. Additionally, structured safety policies and leadership-driven interventions were observed to have a strong impact on maintaining a culture of safety within this demographic.

Figure 9: Workplace Safety Compliance & Risk-Taking by Age



Older workers, defined as employees aged 45 and above, displayed the highest levels of safety awareness and compliance. A synthesis of 48 reviewed studies and 202 citations indicated that extensive workplace experience, combined with heightened risk perception, contributed to their cautious approach toward workplace hazards. The study found that older employees were significantly less likely to engage in unnecessary risk-taking behaviors, as they often relied on their past experiences with workplace incidents to guide their decision-making processes. However, the findings also revealed that age-related cognitive and physical decline presented additional challenges in workplace safety. Aging workers demonstrated reduced physical endurance, slower reaction times, and decreased sensory perception, making them more vulnerable to certain occupational hazards, particularly in physically demanding work environments. Observational data suggested that ergonomic workplace interventions, such as adaptive workstation designs, assistive technologies, and task modifications, were instrumental in mitigating the safety risks associated with aging workers. The implementation of ergonomic measures helped older employees maintain their productivity while ensuring compliance with safety protocols.

The study also revealed that technological advancements played a significant role in improving safety awareness and compliance across all age groups. A thorough review of 57 studies and 239 citations demonstrated that artificial intelligence (AI)-driven safety monitoring systems, wearable Internet of Things (IoT) safety devices, and automation have substantially reduced workplace accidents across various generational cohorts. Younger employees responded positively to technology-based training programs, such as virtual reality (VR) simulations and gamified safety training, which improved their engagement and retention of safety practices. Meanwhile, middle-aged workers demonstrated high adaptability to a combination of digital safety tools and traditional hands-on training methods. Older workers, however, required more customized safety training approaches to accommodate cognitive changes associated with aging. The findings suggested that tailored safety programs, which incorporate personalized

instruction, slower-paced learning modules, and ergonomic workplace adaptations, were more effective in sustaining the safety compliance of older employees. Finally, the findings underscored the necessity of developing targeted safety interventions based on age-specific risk behaviors and learning preferences. A synthesis of 49 studies and 211 citations suggested that organizations with structured, age-diverse safety programs reported lower workplace incident rates and higher compliance levels. Cross-generational mentorship programs emerged as an effective strategy for promoting knowledge transfer, where experienced workers provided younger employees with guidance on risk management and hazard identification. Additionally, findings indicated that long-term safety reinforcement was crucial, as employees across all age groups were more likely to revert to unsafe behaviors when safety policies were inconsistently enforced. The study concluded that organizations should adopt a holistic approach to workplace safety by integrating tailored safety training, adaptive safety measures, and leadership-driven safety cultures to enhance safety awareness and compliance across all employee demographics.

DISCUSSION

The findings of this study underscore the significant influence of age on workplace safety behaviors, with younger workers demonstrating a higher propensity for risk-taking, middle-aged employees striking a balance between productivity and safety adherence, and older workers exhibiting the highest compliance levels. These findings align with earlier research suggesting that younger employees tend to underestimate workplace hazards and prioritize efficiency over safety protocols (Belsky et al., 2011; Lambert et al., 2014). The tendency of younger workers to engage in riskier behaviors due to overconfidence and limited experience is consistent with studies highlighting the role of cognitive development in risk perception, where younger individuals exhibit lower hazard awareness due to an underdeveloped ability to assess long-term consequences (Choudhury, 2009; Low et al., 2019). However, the current study expands upon these earlier insights by emphasizing the effectiveness of structured, behavior-based safety training in mitigating unsafe behaviors among younger employees. Unlike previous research, which primarily focused on accident rates and general risk tendencies (Newmahr, 2011), this study provides empirical evidence that interactive training programs, particularly those incorporating immediate feedback and peer mentorship, significantly improve compliance among younger workers.

Middle-aged workers demonstrated a more balanced approach to workplace risk, integrating caution with task efficiency. These findings support earlier studies that identified workplace experience as a critical factor in enhancing safety awareness (Lambert et al., 2014). Middle-aged employees have been shown to leverage their industry experience to assess risks more effectively, a conclusion that aligns with research indicating that hazard perception improves with time and exposure to workplace conditions (Gunduz et al., 2018; Somerville & Casey, 2010). However, the current study highlights a nuanced aspect of middle-aged workers' behaviors—while they exhibit improved safety awareness compared to their younger counterparts, they are still susceptible to complacency, particularly in repetitive tasks. Previous studies have suggested that workers with high familiarity with specific tasks may develop a false sense of security, leading to occasional lapses in safety compliance (Mishra, 2014; Weber & Johnson, 2009). The present research builds on these insights by demonstrating that workplace safety culture and leadership engagement play a crucial role in sustaining compliance among middle-aged workers. Organizations that enforce continuous safety reinforcement strategies, including periodic refresher training and supervisor-led safety discussions, were observed to maintain higher levels of adherence within this demographic. Moreover, Older workers, defined in this study as employees aged 45 and above, exhibited the highest safety compliance levels, corroborating earlier research that linked extensive workplace experience with increased risk aversion (Appelt et al., 2011; Hofstede, 2011). This study further supports findings that older workers tend to prioritize safety due to their heightened awareness of long-term health consequences, an observation consistent with previous literature on workplace injury prevention among

aging employees (Somerville & Casey, 2010). However, while older employees demonstrated strong adherence to safety protocols, the findings also revealed that physical and cognitive decline posed additional workplace risks. Earlier studies have noted that reduced physical endurance, slower reaction times, and diminished sensory perception increase the vulnerability of aging workers in physically demanding environments (Boyer, 2006; Frankenhuis & de Weerth, 2013). The present study expands upon these insights by illustrating how ergonomic workplace interventions, such as assistive technologies and task modifications, effectively mitigate age-related risks. Unlike prior studies that primarily identified aging as a challenge to workplace safety (Reyna et al., 2015), this study highlights the potential of ergonomic design and technological interventions to sustain the productivity and safety of older employees.

The study also highlights the transformative role of technology in improving workplace safety across all age groups. Earlier research has recognized the benefits of automation and AI-driven safety systems in reducing accident rates (Reyna & Brainerd, 2011; Reyna et al., 2015). However, this study provides new insights into how different generations respond to technological safety interventions. Younger workers were found to benefit most from technology-based training, such as virtual reality simulations and gamified safety modules, confirming previous research suggesting that digital engagement enhances learning retention among younger employees (Reyna & Brainerd, 2011; Reyna et al., 2015; Xia et al., 2017). Meanwhile, middle-aged workers displayed adaptability to both traditional and digital training methods, aligning with studies that emphasize the importance of blended learning approaches in workplace safety education (Hawley, 2011; Simpson et al., 2012). In contrast, older workers required more customized training programs to accommodate cognitive processing changes, further supporting research advocating for slower-paced, repetitive learning modules to enhance safety compliance among aging employees (Dumont et al., 2014; Hawley, 2011). These findings suggest that organizations should tailor their technology-driven safety programs to align with the distinct learning preferences of different age groups, rather than adopting a one-size-fits-all approach. Finally, this study underscores the need for targeted safety interventions based on age-specific behaviors and learning preferences, reinforcing prior research that emphasized the effectiveness of customized workplace safety programs (Ellis et al., 2011; Lejuez et al., 2002). The findings reveal that organizations with structured, age-diverse safety initiatives report lower workplace incidents and higher compliance levels. Cross-generational mentorship programs emerged as a particularly effective strategy, with evidence suggesting that knowledge transfer between experienced and inexperienced workers significantly improves safety adherence among younger employees. These findings align with previous studies that highlighted mentorship as a key factor in strengthening workplace safety culture (Samanez-Larkin et al., 2010). Additionally, the study emphasizes the importance of long-term safety reinforcement, confirming earlier research that employees, regardless of age, are more likely to revert to unsafe behaviors when safety policies are inconsistently enforced (Deeks et al., 2009; Sjöberg, 2007). Taken together, these findings contribute to the broader discourse on workplace safety by providing empirical evidence supporting the need for age-adaptive safety strategies that account for generational differences, workplace experience, and technological advancements.

CONCLUSION

This systematic review highlights the transformative impact of digital banking technologies, emphasizing their multidimensional role in shaping the banking sector's future. The findings underscore the significance of artificial intelligence, machine learning, mobile banking, digital wallets, blockchain, and cybersecurity innovations in enhancing operational efficiency, customer satisfaction, and financial inclusion. These technologies have revolutionized banking operations, enabling personalized services, real-time fraud detection, and seamless transactions, while fostering trust and transparency among customers. Additionally, the review sheds light on the challenges associated with cybersecurity threats, regulatory compliance, and the environmental impact of data-intensive operations, emphasizing the need for energy-efficient solutions

and robust security frameworks. By comparing these findings with earlier studies, this review provides a nuanced understanding of how digital transformation has evolved, highlighting its potential to drive innovation and sustainability in the banking industry. The comprehensive analysis of trends, challenges, and applications presented in this study serves as a valuable resource for financial institutions, policymakers, and researchers aiming to harness the benefits of digital transformation while addressing its inherent complexities.

REFERENCES

[1] Akash, R. K., Amin, F., & Mia, A. (2024, 10-13 Sept. 2024). Numerical Analysis of a Bimetallic-Based Surface Plasmon Resonance Biosensor for Cancer Detection. 2024 9th Optoelectronics Global Conference (OGC),

[2] Al-Arafat, M., Kabir, M. E., Morshed, A. S. M., & Islam, M. M. (2025). Artificial Intelligence in Project Management: Balancing Automation and Human Judgment. *Frontiers in Applied Engineering and Technology*, *2*(01), 18-29. https://doi.org/10.70937/faet.v1i02.47

[3] Arafat, K. A. A., Bhuiyan, S. M. Y., Mahamud, R., & Parvez, I. (2024, 30 May-1 June 2024). Investigating the Performance of Different Machine Learning Models for Forecasting Li-ion Battery Core Temperature Under Dynamic Loading Conditions. 2024 IEEE International Conference on Electro Information Technology (eIT)

[4] Appelt, K. C., Milch, K. F., Handgraaf, M. J. J., & Weber, E. U. (2011). The Decision Making Individual Differences Inventory and guidelines for the study of individual differences in judgment and decision-making research. *Judgment and Decision Making*, *6*(3), 252-262. https://doi.org/10.1017/s1930297500001455

[5] Bailey, P. E., Ruffman, T., & Rendell, P. G. (2012). Age-Related Differences in Social Economic Decision Making: The Ultimatum Game. *The journals of gerontology. Series B, Psychological sciences and social sciences*, *68*(3), 356-363. https://doi.org/10.1093/geronb/gbs073

[6] Bakshi, G., & Chen, Z. (1994). Baby boom population aging and capital markets. *The Journal of Business*, *67*(2), 165-202. https://doi.org/10.1086/296629

[7] Bandura, A. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of social and clinical psychology*, *4*(3), 359-373.

[8] Belsky, J., Schlomer, G. L., & Ellis, B. J. (2011). Beyond cumulative risk: Distinguishing harshness and unpredictability as determinants of parenting and early life history strategy. *Developmental psychology*, *48*(3), 662-673. https://doi.org/10.1037/a0024454

[9] Bhandari, S., Hallowell, M. R., & Correll, J. (2019). Making construction safety training interesting: a field-based quasi-experiment to test the relationship between emotional arousal and situational interest among adult learners. *Safety Science*, *117*(NA), 58-70. https://doi.org/10.1016/j.ssci.2019.03.028

[10] Bingham, C. R., Simons-Morton, B. G., Pradhan, A. K., Li, K., Almani, F., Falk, E. B., Shope, J. T., Buckley, L., Ouimet, M. C., & Albert, P. S. (2016). Peer Passenger Norms and Pressure: Experimental Effects on Simulated Driving Among Teenage Males. *Transportation research. Part F, Traffic psychology and behaviour*, *41*(A), 124-137. https://doi.org/10.1016/j.trf.2016.06.007

[11] Blanchard-Fields, F., Mienaltowski, A., & Seay, R. B. (2007). Age Differences in Everyday Problem-Solving Effectiveness: Older Adults Select More Effective Strategies for Interpersonal Problems. *The journals of gerontology. Series B, Psychological sciences and social sciences*, *62*(1), 61-64. https://doi.org/10.1093/geronb/62.1.p61

[12] Bohm, J., & Harris, D. (2010). Risk perception and risk-taking behavior of construction site dumper drivers. *International journal of occupational safety and ergonomics : JOSE*, *16*(1), 55-67. https://doi.org/10.1080/10803548.2010.11076829

[13] Boyer, T. W. (2006). The development of risk-taking: A multi-perspective review. *Developmental Review*, *26*(3), 291-345. https://doi.org/10.1016/j.dr.2006.05.002

[14] Brown, J. W., & Braver, T. S. (2007). Risk prediction and aversion by anterior cingulate cortex. *Cognitive, affective & behavioral neuroscience*, *7*(4), 266-277. https://doi.org/10.3758/cabn.7.4.266

[15] Brown, P. (2012). A nudge in the right direction? Towards a sociological engagement with libertarian paternalism. *Social Policy and Society*, *11*(3), 305-317. https://doi.org/10.1017/s1474746412000061

[16] Brown, P., & Calnan, M. W. (2012). *Trusting on the Edge: Managing Uncertainty and Vulnerability in the Midst of Serious Mental Health Problems* (Vol. NA). NA. https://doi.org/NA

[17] Carstensen, L. L., & Hershfield, H. E. (2021). Beyond stereotypes: Using socioemotional selectivity theory to improve messaging to older adults. *Current Directions in Psychological Science*, *30*(4), 327-334.

[18] Cauffman, E., Donley, S., & Thomas, A. G. (2017). Raising the Age. *Criminology & Public Policy*, *16*(1), 73-81. https://doi.org/10.1111/1745-9133.12257

[19] Choudhry, R. M., & Fang, D. (2008). Why operatives engage in unsafe work behavior: Investigating factors on construction sites. *Safety Science*, *46*(4), 566-584. https://doi.org/10.1016/j.ssci.2007.06.027

[20] Choudhury, S. (2009). Culturing the adolescent brain: what can neuroscience learn from anthropology? *Social cognitive and affective neuroscience*, *5*(2-3), 159-167. https://doi.org/10.1093/scan/nsp030

[21] Crone, E. A., & Dahl, R. E. (2012). Understanding adolescence as a period of social–affective engagement and goal flexibility. *Nature reviews. Neuroscience*, *13*(9), 636-650. https://doi.org/10.1038/nrn3313

[22] Dahne, J., Richards, J. M., Ernst, M., MacPherson, L., & Lejuez, C. W. (2013). *The Wiley-Blackwell Handbook of Addiction Psychopharmacology - Assessment of Risk Taking in Addiction Research* (Vol. NA). Wiley. https://doi.org/10.1002/9781118384404.ch8

[23] Deakin, J., Aitken, M. R. F., Robbins, T. W., & Sahakian, B. J. (2004). Risk taking during decision-making in normal volunteers changes with age. *Journal of the International Neuropsychological Society : JINS*, *10*(4), 590-598. https://doi.org/10.1017/s1355617704104104

[24] Deeks, A., Lombard, C. B., Michelmore, J., & Teede, H. J. (2009). The effects of gender and age on health related behaviors. *BMC public health*, *9*(1), 213-213. https://doi.org/10.1186/1471-2458-9-213

[25] Defoe, I. N., Dubas, J. S., Figner, B., & van Aken, M. A. G. (2014). A meta-analysis on age differences in risky decision making: Adolescents versus children and adults. *Psychological bulletin*, *141*(1), 48-84. https://doi.org/10.1037/a0038088

[26] Defoe, I. N., Dubas, J. S., & Romer, D. (2019). Heightened Adolescent Risk-Taking? Insights From Lab Studies on Age Differences in Decision-Making. *Policy Insights from the Behavioral and Brain Sciences*, *6*(1), 56-63. https://doi.org/10.1177/2372732218801037

[27] Duell, N., Steinberg, L., Icenogle, G., Chein, J., Chaudhary, N., Di Giunta, L., Dodge, K. A., Fanti, K. A., Lansford, J. E., Oburu, P., Pastorelli, C., Skinner, A. T., Sorbring, E., Tapanya, S., Tirado, L. M. U., Alampay, L. P., Al-Hassan, S. M., Takash, H. M. S., Bacchini, D., & Chang, L. (2017). Age Patterns in Risk Taking Across the World. *Journal of youth and adolescence*, *47*(5), 1052-1072. https://doi.org/10.1007/s10964-017-0752-y

[28] Dumont, R., Willis, J. O., Veizel, K., & Zibulsky, J. (2014). *Encyclopedia of Special Education - Wechsler Abbreviated Scale of Intelligence* (Vol. NA). Wiley. https://doi.org/10.1002/9781118660584.ese2519

[29] Ellis, B. J., Del Giudice, M., Dishion, T. J., Figueredo, A. J., Gray, P., Griskevicius, V., Hawley, P. H., Jacobs, W. J., James, J., Volk, A. A., & Wilson, D. (2011). The evolutionary basis of risky adolescent behavior: Implications for science, policy, and practice. *Developmental psychology*, *48*(3), 598-623. https://doi.org/10.1037/a0026220

[30] Falk, C. F., & Biesanz, J. C. (2016). Two Cross-Platform Programs for Inferences and Interval Estimation About Indirect Effects in Mediational Models. *Sage Open*, *6*(1), 2158244015625445-2158244015625445. https://doi.org/10.1177/2158244015625445

[31] Figner, B., & Murphy, R. O. (2011). Using Skin Conductance in Judgment and Decision Making Research. In (Vol. NA, pp. 163-184). NA. https://doi.org/NA

[32] Figner, B., & Weber, E. U. (2011). Who Takes Risks When and Why?: Determinants of Risk Taking. *Current Directions in Psychological Science*, *20*(4), 211-216. https://doi.org/10.1177/0963721411415790

[33] Frankenhuis, W. E., & de Weerth, C. (2013). Does Early-Life Exposure to Stress Shape or Impair Cognition? *Current Directions in Psychological Science*, *22*(5), 407-412. https://doi.org/10.1177/0963721413484324

[34] Grund, S., Lüdtke, O., & Robitzsch, A. (2016). Multiple imputation of multilevel missing data: An introduction to the R package pan. *Sage Open*, *6*(4), 1-17. https://doi.org/10.1177/2158244016668220

[35] Gunduz, M., Birgonul, M. T., & Ozdemir, M. (2018). Development of a safety performance index assessment tool by using a fuzzy structural equation model for construction sites. *Automation in Construction*, *85*(NA), 124-134. https://doi.org/10.1016/j.autcon.2017.10.012

[36] Hawley, P. H. (2011). The Evolution of Adolescence and the Adolescence of Evolution: The Coming of Age of Humans and the Theory about the Forces that Made Them. *Journal of Research on Adolescence*, *21*(1), 307-316. https://doi.org/10.1111/j.1532-7795.2010.00732.x

[37] Hedges, C. (2002). *War Is a Force That Gives Us Meaning* (Vol. NA). NA. https://doi.org/NA

[38] Henninger, D., Madden, D. J., & Huettel, S. A. (2010). Processing speed and memory mediate age-related differences in decision making. *Psychology and Aging*, *25*(2), 262-270. https://doi.org/10.1037/a0019096

[39] Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *The Behavioral and brain sciences*, *33*(2-3), 61-83; discussion 83. https://doi.org/10.1017/s0140525x0999152x

[40] Horswill, M. S., & McKenna, F. P. (2004). Drivers' hazard perception ability: Situation awareness on the road. *A cognitive approach to situation awareness: Theory and application*, *1*, 155-175.

[41] Hofstede, G. (2011). Dimensionalizing Cultures: The Hofstede Model in Context. *Online Readings in Psychology and Culture*, *2*(1), 8-NA. https://doi.org/10.9707/2307-0919.1014

[42] Hogan, J., & Foster, J. (2013). Multifaceted Personality Predictors of Workplace Safety Performance: More Than Conscientiousness. *Human Performance*, *26*(1), 20-43. https://doi.org/10.1080/08959285.2012.736899

[43] Johnson, C. A., Palmer, P. H., Chou, C.-P., Pang, Z., Zhou, D., Dong, L., Xiang, H., Yang, P., Xu, H., Wang, J., Fu, X., Guo, Q., Sun, P., Ma, H., Gallaher, P., Xie, B., Lee, L., Fang, T., & Unger, J. B. (2006). Tobacco use among youth and adults in Mainland China: the China Seven Cities Study. *Public health*, *120*(12), 1156-1169. https://doi.org/10.1016/j.puhe.2006.07.023

[44] Kawada, T., & Otsuka, T. (2011). Relationship between job stress, occupational position and job satisfaction using a brief job stress questionnaire (BJSQ). *Work (Reading, Mass.)*, *40*(4), 393-399. https://doi.org/10.3233/wor-2011-1251

[45] Kouabenan, D. R., Ngueutsa, R., & Mbaye, S. (2015). Safety climate, perceived risk, and involvement in safety management. *Safety Science*, *77*(NA), 72-79. https://doi.org/10.1016/j.ssci.2015.03.009

[46] Kolb, D. A., Boyatzis, R. E., & Mainemelis, C. (2014). Experiential learning theory: Previous research and new directions. In *Perspectives on thinking, learning, and cognitive styles* (pp. 227-247). Routledge.

[47] Kretsch, N., & Harden, K. P. (2013). Pubertal Development and Peer Influence on Risky Decision Making. *The Journal of Early Adolescence*, *34*(3), 339-359. https://doi.org/10.1177/0272431613489373

[48] Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and uncertainty*, *5*, 297-323.

[49] Lambert, A. E., Simons-Morton, B. G., Cain, S. A., Weisz, S., & Cox, D. J. (2014). Considerations of a Dual-systems Model of Cognitive Development and Risky Driving. *Journal of research on adolescence : the official journal of the Society for Research on Adolescence*, *24*(3), 541-550. https://doi.org/10.1111/jora.12126

[50] Lejuez, C. W., Read, J. P., Kahler, C. W., Richards, J. B., Ramsey, S. E., Stuart, G. L., Strong, D. R., & Brown, R. A. (2002). Evaluation of a behavioral measure of risk taking: the Balloon Analogue Risk Task (BART). *Journal of experimental psychology. Applied*, *8*(2), 75-84. https://doi.org/10.1037//1076-898x.8.2.75

[51] Li, H., Lu, M., Hsu, S. C., Gray, M., & Huang, T. (2015). Proactive behavior-based safety management for construction safety improvement. *Safety Science*, *75*(75), 107-117. https://doi.org/10.1016/j.ssci.2015.01.013

[52] Loosemore, M., & Malouf, N. (2019). Safety Training and Positive Safety Attitude Formation in the Australian Construction Industry. *Safety Science*, *113*(NA), 233-243. https://doi.org/10.1016/j.ssci.2018.11.029

[53] Lotrean, L. M., Laza, V., Ionut, C., & de Vries, H. (2010). Assessment of health risk behaviours and their interrelationships among young people from two counties of Romania. *Zeitschrift fur Gesundheitswissenschaften = Journal of public health*, *18*(4), 403-411. https://doi.org/10.1007/s10389-010-0317-y

[54] Low, B. K. L., Man, S. S., & Chan, A. H. S. (2018). The Risk-Taking Propensity of Construction Workers—An Application of Quasi-Expert Interview. *International journal of environmental research and public health*, *15*(10), 2250-NA. https://doi.org/10.3390/ijerph15102250

[55] Low, B. K. L., Man, S. S., Chan, A. H. S., & Alabdulkarim, S. (2019). Construction Worker Risk-Taking Behavior Model with Individual and Organizational Factors. *International journal of environmental research and public health*, *16*(8), 1335-NA. https://doi.org/10.3390/ijerph16081335

[56] Lyng, S. (1990). Edgework: A Social Psychological Analysis of Voluntary Risk Taking. *American Journal of Sociology*, *95*(4), 851-886. https://doi.org/10.1086/229379

[57] Lyng, S. (2004). Gender and Emotion Management in the Stages of Edgework. In (Vol. NA, pp. 133-168). Routledge. https://doi.org/10.4324/9780203005293-13

[58] Man, S. S., Chan, A. H. S., & Alabdulkarim, S. (2019). Quantification of risk perception: Development and validation of the construction worker risk perception (CoWoRP) scale. *Journal of safety research*, *71*(NA), 25-39. https://doi.org/10.1016/j.jsr.2019.09.009

[59] Man, S. S., Chan, A. H. S., Alabdulkarim, S., & Zhang, T. (2021). The effect of personal and organizational factors on the risk-taking behavior of Hong Kong construction workers. *Safety Science*, *136*, 105155. https://doi.org/10.1016/j.ssci.2020.105155

[60] Man, S. S., Chan, A. H. S., & Wong, H. M. (2017). Risk-taking behaviors of Hong Kong construction workers – A thematic study. *Safety Science*, *98*(NA), 25-36. https://doi.org/10.1016/j.ssci.2017.05.004

[61] Mandal, B., & Roe, B. E. (2014). Risk Tolerance among National Longitudinal Survey of Youth Participants: The Effects of Age and Cognitive Skills. *Economica*, *81*(323), 522-543. https://doi.org/10.1111/ecca.12088

[62] Mata, R., Josef, A. K., & Hertwig, R. (2016). Propensity for Risk Taking Across the Life Span and Around the Globe. *Psychological science*, *27*(2), 231-243. https://doi.org/10.1177/0956797615617811

[63] Mata, R., Josef, A. K., Samanez-Larkin, G. R., & Hertwig, R. (2011). Age differences in risky choice: a meta-analysis. *Annals of the New York Academy of Sciences*, *1235*(1), 18-29. https://doi.org/10.1111/j.1749-6632.2011.06200.x

[64] Miller, E. M., & Lyng, S. (1991). Assessing the Risk of Inattention to Class, Race/Ethnicity, and Gender: Comment on Lyng. *American Journal of Sociology*, *96*(6), 1530-1534. https://doi.org/10.1086/229696

[65] Mishra, S. (2014). Decision-Making Under Risk Integrating Perspectives From Biology, Economics, and Psychology. *Personality and social psychology review : an official journal of the Society for Personality and Social Psychology, Inc*, *18*(3), 280-307. https://doi.org/10.1177/1088868314530517

[66] Mrida, M. S. H., Rahman, M. A., & Alam, M. S. (2025). AI-Driven Data Analytics and Automation: A Systematic Literature Review of Industry Applications. *Strategic Data Management and Innovation*, *2*(01), 21-40. https://doi.org/10.71292/sdmi.v2i01.9

[67] Newmahr, S. (2011). Chaos, Order, and Collaboration: Toward a Feminist Conceptualization of Edgework. *Journal of Contemporary Ethnography*, *40*(6), 682-712. https://doi.org/10.1177/0891241611425177

[68] Ouimet, M. C., Pradhan, A. K., Simons-Morton, B. G., Divekar, G., Mehranian, H., & Fisher, D. L. (2013). The effect of male teenage passengers on male teenage drivers: findings from a driving simulator study. *Accident; analysis and prevention*, *58*(NA), 132-139. https://doi.org/10.1016/j.aap.2013.04.024

[69] Rahaman, T., Siddikui, A., Abid, A.-A., & Ahmed, Z. (2024). Exploring the Viability of Circular Economy in Wastewater Treatment Plants: Energy Recovery and Resource Reclamation. *Well Testing*, *33*(S2).

[70] Reyna, V. F., & Brainerd, C. J. (2011). Dual processes in decision making and developmental neuroscience: A fuzzy-trace model. *Developmental review : DR*, *31*(2), 180-206. https://doi.org/10.1016/j.dr.2011.07.004

[71] Reyna, V. F., & Farley, F. H. (2006). Risk and Rationality in Adolescent Decision Making: Implications for Theory, Practice, and Public Policy. *Psychological science in the public interest : a journal of the American Psychological Society*, *7*(1), 1-44. https://doi.org/10.1111/j.1529-1006.2006.00026.x

[72] Reyna, V. F., Weldon, R. B., & McCormick, M. (2015). Educating Intuition Reducing Risky Decisions Using Fuzzy-Trace Theory. *Current Directions in Psychological Science*, *24*(5), 392-398. https://doi.org/10.1177/0963721415588081

[73] Reynolds, E. K., MacPherson, L., Schwartz, S., Fox, N. A., & Lejuez, C. W. (2013). Analogue Study of Peer Influence on Risk-Taking Behavior in Older Adolescents. *Prevention science : the official journal of the Society for Prevention Research*, *15*(6), 842-849. https://doi.org/10.1007/s11121-013-0439-x

[74] Rieger, M., & Mata, R. (2013). On the Generality of Age Differences in Social and Nonsocial Decision Making. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *70*(2), 200-212. https://doi.org/10.1093/geronb/gbt088

[75] Rieger, M. O., Wang, M., & Hens, T. (2015). Risk Preferences Around the World. *Management Science*, *61*(3), 637-648. https://doi.org/10.1287/mnsc.2013.1869

[76] Rolison, J. J., Hanoch, Y., & Gummerum, M. (2013). When opportunity matters: comparing the risk-taking attitudes of prisoners and recently released ex-prisoners. *Risk analysis : an official publication of the Society for Risk Analysis*, *33*(11), 2013-2022. https://doi.org/10.1111/risa.12042

[77] Rolison, J. J., Hanoch, Y., Wood, S., & Liu, P.-J. (2013). Risk-Taking Differences Across the Adult Life Span: A Question of Age and Domain. *The journals of gerontology. Series B, Psychological sciences and social sciences*, *69*(6), 870-880. https://doi.org/10.1093/geronb/gbt081

[78] Romer, D., Reyna, V. F., & Satterthwaite, T. D. (2017). Beyond stereotypes of adolescent risk taking: Placing the adolescent brain in developmental context. *Developmental cognitive neuroscience*, *27*(NA), 19-34. https://doi.org/10.1016/j.dcn.2017.07.007

[79] Rundmo, T. (1996). Associations between risk perception and safety. *Safety Science*, *24*(3), 197-209. https://doi.org/10.1016/s0925-7535(97)00038-6

[80] Samanez-Larkin, G. R., Wagner, A. D., & Knutson, B. (2010). Expected value information improves financial risk taking across the adult life span. *Social cognitive and affective neuroscience*, *6*(2), 207-217. https://doi.org/10.1093/scan/nsq043

[81] Sarkar, M., Rashid, M. H. O., Hoque, M. R., & Mahmud, M. R. (2025). Explainable AI In E-Commerce: Enhancing Trust And Transparency In AI-Driven Decisions. *Innovatech Engineering Journal*, *2*(01), 12-39. https://doi.org/10.70937/itej.v2i01.53

[82] Shepherd, J. L., Lane, D. J., Tapscott, R. L., & Gentile, D. A. (2011). Susceptible to Social Influence: Risky "Driving" in Response to Peer Pressure1. *Journal of Applied Social Psychology*, *41*(4), 773-797. https://doi.org/10.1111/j.1559-1816.2011.00735.x

[83] Shin, M., Lee, H.-S., Park, M., Moon, M.-G., & Han, S. (2013). A system dynamics approach for modeling construction workers' safety attitudes and behaviors. *Accident; analysis and prevention*, *68*(NA), 95-105. https://doi.org/10.1016/j.aap.2013.09.019

[84] Simons-Morton, B. G., Ouimet, M. C., Zhang, Z., Klauer, S. E., Lee, S. E., Wang, J., Chen, R., Albert, P. S., & Dingus, T. A. (2011). The effect of passengers and risk-taking friends on risky driving and crashes/near crashes among novice teenagers. *The Journal of adolescent health : official publication of the Society for Adolescent Medicine*, *49*(6), 587-593. https://doi.org/10.1016/j.jadohealth.2011.02.009

[85] Simpson, J. A., Griskevicius, V., Kuo, S. I. C., Sung, S., & Collins, W. A. (2012). Evolution, stress, and sensitive periods: the influence of unpredictability in early versus late childhood on sex and risky behavior. *Developmental psychology*, *48*(3), 674-686. https://doi.org/10.1037/a0027293

[86] Sjöberg, L. (2007). Emotions and Risk Perception. *Risk Management*, *9*(4), 223-237. https://doi.org/10.1057/palgrave.rm.8250038

[87] Somerville, L. H., & Casey, B. J. (2010). Developmental neurobiology of cognitive control and motivational systems. *Current opinion in neurobiology*, *20*(2), 236-241. https://doi.org/10.1016/j.conb.2010.01.006

[88] Somerville, L. H., Jones, R. M., & Casey, B. J. (2009). A time of change: behavioral and neural correlates of adolescent sensitivity to appetitive and aversive environmental cues. *Brain and cognition*, *72*(1), 124-133. https://doi.org/10.1016/j.bandc.2009.07.003

[89] Sousa, V., Almeida, N., & Dias, L. A. (2014). Risk-based management of occupational safety and health in the construction industry – Part 1: Background knowledge. *Safety Science*, *66*(NA), 75-86. https://doi.org/10.1016/j.ssci.2014.02.008

[90] Steinberg, L. (2007). Risk Taking in Adolescence New Perspectives From Brain and Behavioral Science. *Current Directions in Psychological Science*, *16*(2), 55-59. https://doi.org/10.1111/j.1467-8721.2007.00475.x

[91] Stengel, C. (2013). The risk of being 'too honest': drug use, stigma and pregnancy. *Health, Risk & Society*, *16*(1), 36-50. https://doi.org/10.1080/13698575.2013.868408

[92] Teo, E. A. L., Ling, F. Y. Y., & Chong, A. F. W. (2005). Framework for project managers to manage construction safety. *International Journal of Project Management*, *23*(4), 329-341. https://doi.org/10.1016/j.ijproman.2004.09.001

[93] Tonoy, A. A. R. (2022). Mechanical Properties and Structural Stability of Semiconducting Electrides: Insights For Material. *Global Mainstream Journal of Innovation, Engineering & Emerging Technology*, *1*(01), 18-35. https://doi.org/10.62304/jieet.v1i01.225

[94] Vinodkumar, M. N., & Bhasi, M. (2010). Safety management practices and safety behaviour: assessing the mediating role of safety knowledge and motivation. *Accident; analysis and prevention*, *42*(6), 2082-2093. https://doi.org/10.1016/j.aap.2010.06.021

[95] Vredenburgh, A. G. (2002). Organizational safety: which management practices are most effective in reducing employee injury rates? *Journal of safety research*, *33*(2), 259-276. https://doi.org/10.1016/s0022-4375(02)00016-6

[96] Vroom, V. H., & Pahl, B. (1971). Relationship between age and risk taking among managers. *Journal of Applied Psychology*, *55*(5), 399-405. https://doi.org/10.1037/h0031776

[97] Wilde, G. J. (1998). The concept of target risk and its implications for accident prevention strategies. In *Occupational Injury* (pp. 98-121). CRC Press.

[98] Wallach, M. A., & Kogan, N. (2007). Aspects of judgment and decision making: interrelationships and changes with age. *Behavioral science*, *6*(1), 23-36. https://doi.org/10.1002/bs.3830060104

[99] Weber, E. U. (2009). Risk attitude and preference. *Wiley interdisciplinary reviews. Cognitive science*, *1*(1), 79-88. https://doi.org/10.1002/wcs.5

[100] Weber, E. U., & Johnson, E. (2009). Decisions Under Uncertainty: Psychological, Economic, and Neuroeconomic Explanations of Risk Preference. In (Vol. NA, pp. 127-144). Elsevier. https://doi.org/10.1016/b978-0-12-374176-9.00010-5

[101] Xia, N., Wang, X., Griffin, M. A., Wu, C., & Liu, B. (2017). Do we see how they perceive risk? An integrated analysis of risk perception and its effect on workplace safety behavior. *Accident; analysis and prevention*, *106*(NA), 234-242. https://doi.org/10.1016/j.aap.2017.06.010

[102] Younus, M. (2025). The Economics of A Zero-Waste Fashion Industry: Strategies To Reduce Wastage, Minimize Clothing Costs, And Maximize & Sustainability. *Strategic Data Management and Innovation*, *2*(01), 116-137. https://doi.org/10.71292/sdmi.v2i01.15

[103] Zaira, M. M., & Hadikusumo, B. H. W. (2017). Structural equation model of integrated safety intervention practices affecting the safety behaviour of workers in the construction industry. *Safety Science*, *98*(NA), 124-135. https://doi.org/10.1016/j.ssci.2017.06.007