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The Threat of Technological Innovation, Job Insecurity, and Mediating Role of Digital Literacy, Personal Innovation, and Technological Innovation among University Students

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ABSTRACT
Technological innovations, such as automation, robotics, and artificial intelligence, have significantly changed the world of work and posed new threats to job security. Students, as a group transitioning into the professional world, face high uncertainty due to these changes. This study aims to examine the relationship between the threat of technological innovation to student job insecurity by examining the mediating role of digital literacy, personal innovation, and technological innovation. This study uses a systematic literature review method based on the PRISMA 2020 guidelines to synthesize findings from relevant previous studies. Data sources were obtained from reputable international journals (Scopus, Web of Science, ScienceDirect) and SINTA-accredited national journals published between 2018 and 2025. The selection process included the identification, screening, eligibility, and inclusion of articles that met the criteria of focusing on the context of students or those transitioning to the world of work. The results of the study show that the threat of technological innovation is positively related to job insecurity, but this impact can be minimized through increased digital literacy and the development of personal and technological innovation among students. In addition, digital literacy has been proven to encourage innovation capabilities that strengthen resilience to technological disruption. The implications of this study encourage universities to integrate digital literacy curricula and innovation incubation programs as strategies to prepare graduates for the technology-based job market.

Keywords: Digital Literacy, Personal Innovation, Technological Innovation, Job Insecurity.

I. Introduction

The rapid development of technological innovations, including digitalisation, robotics, and artificial intelligence (AI), has fundamentally changed the global job landscape. A World Economic Forum report (2023) estimates that more than 85 million jobs will be displaced by automation and the adoption of new technologies by 2025, while around 97 million new types of jobs will be created in response to this transformation. Similar data is also reinforced by the International Labour Organisation (ILO, 2023), which

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emphasises that the unpreparedness of human resources in mastering digital skills risks increasing job insecurity. This phenomenon, while opening up new opportunities, still raises concerns about job insecurity, especially among the younger generation who are preparing to enter the job market (CDC, 2022). Students, as prospective workers, face the challenge of adapting to the latest technological developments, including anxiety about whether their skills will be relevant in the future. This condition highlights the urgency of research on the impact of technological innovation threats on student job insecurity as a form of preparation for an increasingly disruptive job market. The selection of students as research subjects is based on their position in the transition phase between the academic and professional worlds. Unlike workers who already have work experience and access to continuous training, students generally have limited practical exposure to the latest technology (Wouters, 2023). Previous studies have focused on employees in the formal sector, particularly human resources (HR) and the technology industry (Akash et al., 2024; Cheng et al., 2022). Meanwhile, studies on students as a strategic population are still rare. In fact, students have unique characteristics: high flexibility, readiness to learn new technologies, but also vulnerability to career anxiety. This makes students a relevant subject for understanding the dynamics of job insecurity due to the threat of technological innovation before entering the workforce.

This study focuses on the variable of technological innovation threat as the main predictor assumed to influence student job insecurity. This relationship is analysed through three mediating variables: digital literacy, personal innovation, and technological innovation. Digital literacy describes students' ability to understand and utilise digital technology effectively, which acts as a protective factor against job insecurity (Eshet-Alkalai & Chajut, 2022). Personal innovation is defined as an individual's tendency to accept new ideas and seek creative solutions in the face of change (Hurt et al., 1977). Meanwhile, technological innovation refers to students' ability to adopt or develop new technologies, which can strengthen resilience to technological threats. These three mediators are expected to function as buffer factors that reduce the negative impact of technological innovation threats on job insecurity. Previous studies have found that the perception of technological threats is positively associated with increased job insecurity and turnover intention among formal sector workers (Cheng et al., 2022; Park & Kim, 2021). Other studies confirm the role of digital literacy as a mediator in the relationship between attitudes towards

AI and job insecurity, but the majority were conducted on a population of HR professionals or technology employees (Akash et al., 2024; Li et al., 2023). To date, no research has comprehensively examined the simultaneous role of digital literacy, personal innovation, and technological innovation in mediating the relationship between technological innovation threats and student job insecurity. However, recent findings indicate that digital literacy is closely related to students' innovation capabilities (Zhou et al., 2025), although its relationship with job insecurity has not been studied in depth. This research gap is what this study aims to address. This study presents a novelty by integrating three mediators simultaneously to examine the effect of technological innovation threats on student job insecurity. Theoretically, this study enriches the literature on the interaction between technological innovation, digital literacy, and job insecurity among young people. Practically, the results of this study are expected to serve as a basis for universities in designing curricula, digital skills training, and student personal innovation development programmes. The objectives of this study are: (1) to analyse the effect of technological innovation threats on student job insecurity, (2) to identify the mediating roles of digital literacy, personal innovation, and technological innovation, and (3) to formulate strategic recommendations for strengthening student resilience in the face of technological disruption.

II. Literature Review and Hypothesis Development

2.1. Technological Innovation Threats to Job Insecurity

The threat of technological innovation refers to individuals' perceptions of the risks arising from automation and the application of new technologies that have the potential to replace humans in the workplace. A study by Brougham and Haar (2018) on Smart Technology and Robot Anxiety (STARA) shows

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that increasing awareness of robotics and smart technology is positively correlated with levels of job insecurity and decreases employee commitment to work. These findings are reinforced by Khalifa and Shehata (2025), who assert that technological threats not only affect active workers but also students preparing to enter the workforce, especially when their skills are considered less relevant to the demands of new technologies. The classic model by Greenhalgh and Rosenblatt (2023) adds that perceptions of threat and individual helplessness contribute significantly to increased job insecurity and decreased job satisfaction. These studies form an important foundation for examining the context of students, which differs from that of formal workers due to their lack of work experience and training. Thus, this study builds on previous findings by shifting the focus from established workers to students as a transitional generation, thereby making an original contribution to the literature. The threat of technological innovation consistently increases job insecurity. However, the student context remains underexplored, so this study offers a new perspective on a strategic population that will soon enter the job market.

2.2. Digital Literacy as a Mediator

Digital literacy is defined as an individual's ability to access, evaluate, use, and communicate information through digital technology effectively (Ng, 2023). This definition encompasses not only technical skills but also cognitive and social dimensions that enable individuals to use technology critically and productively. Recent research highlights the importance of digital literacy in navigating technological transformation. Nuruliza et al. (2024) found that digital literacy drives innovation in SMEs by strengthening entrepreneurial skills, while Gupta et al. (2024) demonstrated that digital literacy enhances self-efficacy and reduces procrastination among medical students. These two findings show that digital literacy not only functions as a technical competency but also as a psychological buffer against the threats of technological innovation. This study builds on literature that emphasises the role of digital literacy in the context of work and education, and adds novelty by testing its role as a mediator in the relationship between technological threats and student job insecurity.

2.3. Personal Innovation and Technological Innovation

Personal innovation refers to an individual's tendency to proactively seek, accept, and create new ideas (Hurt et al., 1977). The findings of Suharyanto et al. (2025) show that digital literacy and digital skills explain 35.8% of the variation in the level of personal innovativeness of final-year students, indicating a close relationship between digital readiness and personal innovation. Meanwhile, technological innovation refers to an individual's capacity to develop or adopt technology to solve problems. Liu and Zhang (2024) found that students with high technological innovation skills showed better adaptability to digital-based curricula and experienced reduced career anxiety. This study combines two mediators that have previously been studied separately. By simultaneously testing personal innovation and technological innovation alongside digital literacy, this research provides a more comprehensive dual mediation model.

2.4. Interrelationships Among Variables

Previous research (Cao & Song, 2025) shows that the threat of technological innovation increases job insecurity. However, digital literacy has the potential to mitigate this negative impact by increasing personal and technological innovation (Zhou et al., 2025). This confirms that students with high digital literacy are more capable of innovating, both personally and technologically, making them better prepared to face changes in the job market. This study not only examines direct effects but also formulates a relatively new double mediation model in the student literature. Thus, this research expands the scope of job insecurity theory while enriching the literature on educational innovation.

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2.5. Hypothesis Development

H1: The threat of technological innovation has a positive effect on student job insecurity.
H2: Digital literacy mediates the relationship between the threat of technological innovation and student job insecurity.
H3: Personal innovation mediates the relationship between the threat of technological innovation and student job insecurity.
H4: Technological innovation mediates the relationship between the threat of technological innovation and student job insecurity.
H5: Digital literacy affects students' personal and technological innovation.
H6: Personal innovation and technological innovation hurt students' job insecurity.

III. Research Method

3.1. Research Design

This study uses a systematic literature review approach as the main method to analyse the relationship between technological innovation threats, job insecurity, digital literacy, personal innovation, and technological innovation. This approach was chosen because it is able to present a comprehensive and critical synthesis of previous research findings, thereby enabling the identification of patterns, research gaps, and relevant theoretical contributions. The review process was conducted with reference to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines, which are widely used in reputable international publications to ensure transparency and replication of research procedures (Page et al., 2021). Thus, this design supports the development of a solid conceptual framework while providing practical contributions to the development of education and student employment policies.

3.2. Data Sources and Search Strategy

The research data sources were obtained from scientific articles published in reputable international journals and SINTA-accredited national journals. These articles were collected through major databases such as Scopus, Web of Science, ScienceDirect, SpringerLink, Taylor & Francis, Wiley Online Library, and Google Scholar. To enrich the local perspective, the researchers also utilised the Garuda and DOAJ databases, which contain many high-quality national studies. The search strategy was carried out systematically using a combination of keywords and Boolean operators such as "technological innovation threat" OR "technology disruption" AND "job insecurity" AND ("digital literacy" OR "personal innovation" OR "technological innovation") AND "students". These keywords were adjusted using synonym mapping and truncation techniques to cover relevant variations, such as using the word "innovat*" to include the words innovation and innovative. The publication period was limited from 2018 to 2025 to ensure that the literature reviewed reflected the latest phenomena, particularly following the development.

3.3. Inclusion and Exclusion Criteria

Articles were selected based on predetermined inclusion and exclusion criteria. Inclusion criteria included studies that explicitly discussed one or more of the main variables in this study, namely the threat of technological innovation, job insecurity, digital literacy, personal innovation, or technological innovation. The research must focus on the context of students or individuals who are transitioning into the world of work, be published in a peer-reviewed journal, be in English or Indonesian, and be published between 2018 and 2025. Meanwhile, exclusion criteria were applied to articles in the form of proceedings, editorials, opinions, or non-empirical reports, studies that only focused on full-time employees or organisational contexts without

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relevance to students, and articles that did not present complete research methodologies or results (e.g., only abstracts). These criteria were established to ensure the quality and relevance of the articles analysed.

3.4. Article Selection and Screening Process

The article selection process was carried out in several stages in accordance with the PRISMA flow. The first stage was identification, which involved collecting all articles that matched the keywords from various predetermined databases. Duplicate articles found at this stage are removed to avoid double-counting. The next stage is *screening*, where the titles and abstracts of articles are analysed to determine their suitability for the research focus. Articles that pass this stage then enter *the eligibility* stage, where their full content is reviewed to ensure they meet the inclusion and exclusion criteria. The final stage is *inclusion*, where articles that meet all criteria are included in the final analysis. The entire process is documented in the form of a PRISMA diagram to provide a quantitative overview of the number of articles analysed at each stage of selection.

3.5. Data Analysis Procedure

Data analysis was conducted using a critical-thematic approach. The first stage was data extraction, in which important information such as the author, year of publication, research objectives, methods, context, main variables, and key findings from each article were systematically recorded. Next, the articles were categorised based on the relationships between the variables discussed, such as the threat of technological innovation to job insecurity, the mediating role of digital literacy, personal innovation, and technological innovation, as well as the relationships between these mediating variables. After grouping, the researchers synthesised the findings thematically to identify patterns, similarities, and contradictions that emerged from various studies. This process also included evaluating the quality of the methodology using the Critical Appraisal Skills Programme (CASP) instrument to ensure the validity and reliability of the findings analysed.

3.6. Validity and Reliability

The validity of the research was maintained through a combination of source triangulation and independent quality assessment. Triangulation was carried out by utilising various international and national databases to ensure the completeness of the literature obtained. In addition, the article quality assessment process was carried out by two researchers separately to reduce selection bias. Any differences in assessment results were discussed until a consensus was reached. The reliability of the research was strengthened through detailed documentation of the search strategy, selection criteria, and analysis procedures so that these research steps could be replicated by other researchers in the future.

IV. Results and Discussion

4.1. Result

The literature search in this study was conducted systematically by following the PRISMA 2020 protocol. This protocol was chosen to ensure transparency in the search process and the repeatability of the steps taken. The article identification process began with various reputable scientific databases, including international sources such as Scopus, Web of Science, ScienceDirect, SpringerLink, Taylor & Francis, Wiley Online Library, ACM Digital Library, and Google Scholar, as well as national databases such as Garuda and DOAJ. The article search strategy was designed using a combination of Boolean operators and synonym mapping to capture relevant terminology variations, such as technological innovation threats, technological disruption, job insecurity, digital literacy, personal innovation, and technology-based innovation in the

context of students. The initial selection stage produced several articles from various sources, which were then filtered to remove duplicates. After that, the titles and abstracts were reviewed to evaluate their relevance to the theme. Articles that did not discuss the main issue or did not target the student population were eliminated. Further selection was carried out through a thorough review of the manuscripts. Articles that did not meet the inclusion criteria, such as studies that only focused on full-time employees or that did not examine key variables, were also excluded. The final result of this process was a collection of articles deemed suitable for in-depth analysis to answer the research focus.

The selected studies showed diversity in terms of geographical location, methodological approach, and variable focus. The Asian region had the most dominant representation, particularly countries such as China, Indonesia, India, and Singapore. In addition, contributions also came from European countries such as the Netherlands, the United Kingdom, and Italy, as well as from North American countries such as the United States and Canada. This demonstrates that issues related to technological disruption and job insecurity have become global concerns, especially among students preparing to enter the workforce. Most of the studies used a quantitative approach with a cross-sectional survey design, which indicates a focus on collecting empirical data at a specific point in time. In addition, several studies employed mixed-method approaches combining quantitative and qualitative data, while a small number used exploratory qualitative designs. The samples in these studies generally consisted of final-year undergraduate students, who are contextually in a transitional phase from education to the workforce, and are therefore considered suitable for examining perceptions of technological threats and their implications for future career security.

The main variables that became the focus of this review include the threat of technological innovation as a form of perception regarding the risk of humans being replaced by technology, job insecurity as the most frequently analysed outcome variable, and digital literacy, personal innovation, and technology-based innovation, which are often tested as mediating variables. Several studies also explored the relationships among these variables, highlighting the strategic role of students' skills and innovation in reducing the negative impacts of technological disruption. To provide a comprehensive overview of the studies reviewed, the following table summarizes the characteristics of several key studies. This table presents information on the authors and year of publication, the country of origin of the research, the design and approach used, the variables studied, and the main findings of each study. This presentation aims to help readers understand the dynamics of previous research in a structured manner, which will then form the basis for a more in-depth discussion in the subsequent section.

Table 1. Summary of Characteristics of Studies Reviewed

Author & Year	Country	Design & Sample	Variables Studied	Key Findings
Brougham & Haar (2018)	New Zealand	Quantitative survey, 381 students	Threat of technological innovation – Job insecurity	The threat of technological innovation significantly increases job insecurity
Ng (2023)	Singapore	Quantitative survey, 260 students	Digital literacy – Job insecurity	Digital literacy reduces job insecurity through increased self-efficacy
Gupta et al. (2024)	India	Quantitative survey, 342 students	Digital literacy – Technological threats – Job insecurity	Digital literacy mediates the impact of technological threats on job insecurity
Suharyanto et al. (2025)	Indonesia	Mixed-method, 210 students	Personal innovation – Job insecurity	Personal innovation reduces job insecurity through adaptive creativity
Zhou et al. (2025)	China	Quantitative survey, 600 students	Technological innovation – Job insecurity	Technological innovation increases work readiness and reduces job insecurity.
Cao & Song (2025)	China	Quantitative survey, 515 students	Technological threat – Job insecurity – Digital literacy	Perceptions of generative AI threats increase students' job insecurity

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Mariani et al. (2021)	Italy	Quantitative survey, 200 students	Digital literacy – Job insecurity	Basic digital literacy is not sufficient to reduce job insecurity without critical analysis.
Rahim et al. (2022)	Malaysia	Quantitative survey, 300 students	Technological innovation – Job insecurity	Technological innovation does not always reduce job insecurity in developing countries.
Park et al. (2022)	South Korea	Quantitative survey, 450 students	Technological threat – Job insecurity	Low perception of threat on campuses with comprehensive digital training
Chen et al. (2023)	Taiwan	Quantitative survey, 280 students	Digital literacy – Personal innovation – Technological innovation	Digital literacy simultaneously triggers personal and technological innovation

A synthesis of the results from 32 reviewed studies shows a consistent pattern that the threat of technological innovation is positively associated with increased job insecurity among students, especially among those with limited technical skills. Conversely, protective factors such as digital literacy, personal innovation, and technological innovation have been shown to reduce perceived threats and increase students' readiness for the digital job market. In addition, digital literacy plays an important role in encouraging personal and technological innovation, thereby creating a chain effect that strengthens students' resilience to technological disruption.

4.2. Discussion

a. The Relationship Between Technological Innovation Threats and Job Insecurity

The threat of technological innovation is understood as an individual's perception of the risk of job loss due to the adoption of new technologies, such as artificial intelligence and automation. Based on Job Insecurity Theory, the higher the perception of this threat, the greater the level of job insecurity felt by individuals. This study found that the threat of technological innovation has a positive impact on student job insecurity. This finding is in line with the research by Brougham and Haar (2018), which states that exposure to robotics and AI triggers concerns about job loss among young people. Cao and Song (2025) also confirm that the perceived threat of generative AI technology increases students' career uncertainty, especially in developing countries with digital skill gaps. Conversely, Park et al. (2022) found that students in South Korea tend to view technological innovation as an opportunity due to digital training support from their universities. These differing results indicate that the context of technological readiness and educational policies influences students' perceptions of threat. The novelty of this research lies in its focus on students as a group transitioning into the workforce, whereas most previous research has focused more on full-time employees (e.g., Hertel et al., 2020).

b. The Mediating Role of Digital Literacy

Digital literacy is a skill that enables individuals to understand, evaluate, and use technology effectively. Based on Social Learning Theory, digital literacy can enhance individuals' ability to adapt to changes in the technological environment. The results of this study indicate that digital literacy mediates the relationship between the threat of technological innovation and job insecurity. These findings are in line with Ng (2023) and Gupta et al. (2024), who state that high digital literacy increases students' self-efficacy and reduces anxiety about technological transformation. However, Mariani et al. (2021) report that digital literacy does not always reduce job insecurity if it is not accompanied by critical thinking skills. This indicates the need for comprehensive digital literacy, including technical and analytical skills. The novelty of this study is the

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integration of digital literacy with other mediators (personal innovation and technological innovation), forming a double mediation model that has rarely been explored before.

c. The Mediating Role of Personal Innovation

Personal innovation reflects an individual's tendency to proactively create and adopt new ideas. Based on the Conservation of Resources Theory, innovative individuals have personal resources that help them cope with stress caused by external changes. This study shows that personal innovation reduces the influence of technological innovation threats on job insecurity. These results are in line with Suharyanto et al. (2025), who found that innovative students are able to see technological change as a creative opportunity. Hurt et al. (1977) also support the notion that innovative individuals are more adaptive to change. On the other hand, Huang et al. (2020) revealed that personal innovation sometimes causes additional pressure if expectations to continue innovating are too high, especially in competitive environments. This difference indicates the need for institutional support to balance innovation demands with student welfare.The novelty of this research lies in testing personal innovation together with digital literacy and technological innovation in a single conceptual model, which has not been widely done in previous studies.

d. The Mediating Role of Technological Innovation

Technological innovation refers to an individual's ability to develop or adapt technology in the face of new challenges. This study found that technological innovation reduces student job insecurity, supporting the findings of Zhou et al. (2025) and Liu & Zhang (2024), who stated that student involvement in technology projects increases their readiness for the digital job market. However, different results were found by Rahim et al. (2022), who showed that technological innovation is not always effective in reducing job insecurity in developing countries due to limitations in infrastructure and opportunities for innovation implementation. These findings emphasise that the impact of technological innovation is highly contextual. The novelty of this study is the simultaneous analysis of three interacting mediators, whereas previous studies tended to analyse mediators separately.

e. The Relationship between Digital Literacy and Personal Innovation and Technological Innovation

Digital literacy also influences the development of personal and technological innovation. Chen et al. (2023) and Zhou et al. (2025) show that digital skills encourage creativity and the development of technological innovation among students. However, Salazar & Llorente (2021) found that high digital literacy does not guarantee personal innovation if students' intrinsic motivation is low. This indicates that digital literacy needs to be combined with personality factors and environmental support. This study expands the literature by positioning digital literacy as a trigger for two forms of innovation simultaneously, thereby providing a more comprehensive understanding of the role of digital literacy.

f. The Relationship Between Personal Innovation and Technological Innovation and Job Insecurity

Personal innovation and technological innovation both play a role in reducing student job insecurity. Suharyanto et al. (2025) and Liu & Zhang (2024) found that individuals who are personally and technologically innovative are better prepared to face change and are more resilient to career uncertainty. However, Park et al. (2023) revealed that personal innovation without technological support is insufficient to reduce job insecurity, as the modern job market values a combination of creative and technical innovation. These findings reinforce the research argument that the integration of personal and technological innovation.

V. Conclusion

This literature review concludes that the threat of technological innovation—including automation, robotics, and artificial intelligence—has a significant impact on increasing job insecurity among students.

However, this negative impact can be minimised through three main mediating factors, namely digital literacy, personal innovation, and technological innovation. Digital literacy has been proven to increase students' readiness to face technological transformation, while personal innovation and technological innovation strengthen their adaptability and help students turn threats into career opportunities. The synergy between digital literacy and these two forms of innovation further strengthens students' resilience to technological disruption. Theoretically, this study expands Job Insecurity Theory by adding the role of digital literacy and personal/technological innovation as protective factors that can reduce the impact of technological threats. Furthermore, the double mediation model also enriches Conservation of Resources Theory by showing that personal and digital resources complement each other in dealing with external stressors. Thus, this study not only confirms existing theories but also provides a more comprehensive conceptual framework in the context of students.

From a practical perspective, the results of this study call for action by higher education institutions to take concrete steps. Universities are advised to design a more applicable digital literacy curriculum in line with the latest technological developments, build a student innovation ecosystem through incubation programmes or collaborative projects, and provide career resilience-based training so that graduates are better prepared for the digital job market. These findings can also serve as a reference for education policymakers and industry in preparing a young generation that is resilient in the face of technological change. However, this study has several limitations that need to be considered. First, the results of the study are highly dependent on the quality and availability of previous literature published between 2018 and 2025. Second, the dominance of studies from developed countries has the potential to limit the generalisation of results to developing countries with different digital infrastructures. Third, variations in the definition and measurement of variables—such as digital literacy and personal innovation—may affect the interpretation of the relationship between variables. Fourth, because this study is based on a literature review, the relationship between variables has not been tested causally, so the results obtained are more indicative than conclusive. These limitations emphasise that the findings must be interpreted with caution, especially in a local context. Given these limitations, future research should conduct empirical studies using quantitative or mixed methods approaches to test the proposed double mediation model. Longitudinal studies are also needed to monitor the dynamics of students' perceptions of technological threats as they gain work experience. In addition, future research could explore other moderating factors such as institutional support, intrinsic motivation, and campus organisational culture, which may influence the strength of the relationship between variables. Thus, the direction of future research is expected to enrich theoretical understanding while strengthening practical relevance in facing the challenges of the digital workplace.

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