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The Role of Risk Management and Digital Technology Literacy in Enhancing Student Resilience: The Moderating Effect of Modern Learning Environments in the Digital Era

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Abstract: The rapid digital transformation in higher education has highlighted the importance of adaptive learning environments and strategies that foster student resilience. This study investigates the influence of risk management and digital technology literacy on student resilience, with the modern learning environment as a moderating variable. Using a quantitative approach, data were collected from 475 undergraduate students across various universities in Indonesia through an online survey. Structural Equation Modeling-Partial Least Squares (SEM-PLS) was employed to analyze the relationships between the variables. The findings reveal that both risk management and digital technology literacy have significant positive effects on student resilience. Moreover, the modern learning environment strengthens these relationships by providing students with reliable digital infrastructure and innovative learning strategies that amplify the impact of institutional policies and individual competencies. These results underscore the critical role of robust risk management, comprehensive digital literacy programs, and high-quality modern learning environments in fostering resilience among students. This study contributes to the theoretical understanding of resilience by integrating institutional, individual, and environmental factors. Practically, it provides insights for higher education institutions to develop integrated strategies that enhance risk management frameworks, promote digital literacy, and invest in inclusive, technology-driven learning ecosystems to better prepare students for academic and professional challenges in the digital era.

Keywords: student resilience; risk management; digital technology literacy; modern learning environment; higher education

1. Introduction

The rapid digital transformation in higher education has created significant challenges, requiring students to adapt to dynamic learning environments. Globally, 85% of universities have adopted digital platforms post-COVID-19, while in Indonesia, 78% of students report heightened stress during the transition to online learning (Matsieli & Mutula, 2024; Wollscheid et al., 2023). Student resilience, defined as the ability to adapt positively to academic challenges, has become essential for academic success (A., & M. H. Martin, 2020; Minnett & Stephenson, 2024). Resilient students are better equipped to handle stress, adapt to technological changes, and sustain motivation (Motz et al., 2023; Yu, 2022a). However, fostering resilience requires support through risk management, digital literacy, and modern learning environments.

Risk management involves identifying and mitigating risks that disrupt learning, such as cybersecurity issues and technological failures (Guaña-Moya et al., 2024a). Effective strategies enable

institutions to maintain learning continuity during disruptions like the COVID-19 pandemic and equip students to navigate uncertainties (Huang et al., 2024; Worldbank, 2024). At the individual level, risk management frameworks help students develop resilience by providing tools to manage academic challenges (Holdsworth et al., 2019; Matías-García et al., 2024; Ye et al., 2021).

Digital technology literacy, the ability to effectively use and integrate digital tools, is another critical factor (Bulut et al., 2023; Meridha, 2024; Zhu et al., 2023). Students with high digital literacy adapt better to hybrid learning, engage more effectively with digital platforms, and utilize resources efficiently (Buchan et al., 2024; Otto et al., 2024; Yuan et al., 2024). This skill not only facilitates learning but also strengthens resilience by enabling students to overcome technological barriers (Meridha, 2024; Qi & Yang, 2024a).

A modern learning environment moderates the relationship between these factors and resilience. It combines innovative teaching strategies, such as personalized learning, with robust digital infrastructure to create adaptive ecosystems (Demir, 2021; Xu et al., 2024). Interactive approaches enhance engagement, while accessible technology ensures seamless integration of learning tools (Depedtambayan, n.d.; Fitzgerald & Evans, 2024). Despite advancements, research integrating risk management, digital literacy, and modern learning environments to foster resilience remains limited (Drossel et al., 2020; Qi & Yang, 2024b). Most studies address these factors in isolation, neglecting their collective impact in supporting students' adaptability in higher education (Otto et al., 2024; Zhou et al., 2024).

This study addresses this gap by analyzing the relationships between risk management, digital technology literacy, and student resilience, with modern learning environments as a moderating variable. Using a quantitative approach and structural equation modeling, this research provides empirical insights into how institutions can enhance resilience through digital adaptation strategies. The findings contribute theoretically by expanding understanding of resilience in digital learning and practically by offering recommendations for creating adaptive educational ecosystems (Rojas & Chiappe, 2024).

2. Theoretical Basis and Research Hypothesis

2.1. Risk Management

Risk management in higher education refers to systematic efforts to identify, assess, and mitigate risks that can disrupt academic processes, especially in the digital era (Dursun, 2024; Khaw & Teoh, 2023; Ruzic-Dimitrijevic, 2014). This includes addressing technological risks, such as cybersecurity threats, data breaches, and system failures, which have become prevalent with the increasing reliance on digital platforms (Gourisaria et al., 2023; Guaña-Moya et al., 2024b; Haque et al., 2023). The Committee of Sponsoring Organizations (COSO) framework emphasizes the need for integrating risk management into educational strategies to ensure resilience and sustainability in learning environments (COSO, n.d.). Studies have highlighted that institutions with comprehensive risk management systems are better equipped to navigate crises, such as the COVID-19 pandemic, minimizing disruptions and enhancing institutional adaptability (Izumi, 2022; Shaya et al., 2023).

At the individual level, risk management plays a vital role in equipping students with tools to cope with uncertainties. For instance, structured support systems that identify academic risks, such as workload imbalances or resource shortages, empower students to develop resilience and maintain motivation (Beale, 2023; Ross et al., 2023). Research shows that when students are provided with clear frameworks to manage risks, they exhibit higher engagement and better academic outcomes (Lagubeau, 2020; Wong & Liem, 2022). Furthermore, effective risk management promotes mental well-being, as students feel more secure and supported in unpredictable environments (Barbayannis et al., 2022; Campbell et al., 2022; Ramos-Monsivais et al., 2024)These findings underscore the importance of integrating risk management not only at the institutional level but also as a critical component of student development in the digital learning era.

2.2. Digital Technology Literacy

Digital technology literacy, defined as the ability to effectively use, evaluate, and integrate digital tools, is a foundational skill for success in modern higher education (Holm, 2024; Quraishi, 2024). It encompasses competencies such as navigating digital platforms, utilizing educational technologies, and critically assessing digital information (Spante et al., 2018; Tondeur et al., 2023). As digital learning environments become the norm, especially post-COVID-19, institutions increasingly rely on students' technological literacy to ensure meaningful engagement and academic success (Akpen et al., 2024; Kim et al., 2019). Studies have found that students with strong digital literacy demonstrate higher adaptability to hybrid and online learning systems, improved academic performance, and greater autonomy in learning (Akpen et al., 2024; "The Relationship between Digital Literacy and Academic Performance of College Students in Blended Learning: The Mediating Effect of Learning Adaptability," 2023; Widowati et al., 2023)

Moreover, digital literacy supports learning innovation by enabling students to optimize the use of tools such as virtual labs, collaborative platforms, and adaptive learning technologies (Reyaz Ahmad Bhat, 2023). These skills also enhance resilience, as students with high digital literacy are better equipped to overcome challenges related to remote or hybrid learning environments (Polat, 2024; Yu, 2022b). However, disparities in access to digital resources and skills highlight the importance of institutional support in fostering equitable digital literacy development (Assefa et al., 2024; Kuhn et al., 2023; Vishnu et al., 2024). Recent frameworks emphasize the need for structured interventions to bridge digital divides and equip students with advanced digital competencies for academic and professional success (Handley, 2018; Jisc, 2023)

2.3. Modern Learning Environment

A modern learning environment (MLE) integrates innovative teaching strategies and advanced digital infrastructure to create dynamic, engaging, and adaptive ecosystems for students (Khanal, 2024; Zone of Education, n.d.). This concept emphasizes personalization, interactivity, and accessibility, ensuring that students can thrive in hybrid or fully digital learning settings (Kerimbayev et al., 2023; Peng et al., 2019). Personalized learning approaches, such as adaptive learning technologies and student-centered pedagogies, have been shown to significantly enhance student engagement and academic outcomes (El-Sabagh, 2021; Kerimbayev et al., 2023; Mejeh & Rehm, 2024). Additionally, interactive components, including virtual labs and collaborative platforms, foster active participation and critical thinking (Baanqud et al., 2020; Elmoazen et al., 2023; Y.-L. Lin & Wang, 2024; Tang et al., 2023). These innovations create an ecosystem where students are better equipped to adapt to academic and technological challenges.

The digital infrastructure within MLEs, including reliable internet connectivity, high-quality learning management systems, and user-friendly tools, is a critical component of its success (Otto et al., 2024; Vishnu et al., 2024). A robust infrastructure ensures seamless integration of educational technologies and minimizes disruptions that could hinder learning (Timotheou et al., 2023). Recent studies indicate that institutions with well-developed MLEs report higher levels of student satisfaction, resilience, and performance compared to traditional environments (Contrino et al., 2024; Keržič et al., 2021; Wang et al., 2024). Furthermore, these environments enable inclusivity by providing access to learning for diverse student populations, including those in remote areas (Contrino et al., 2024; El Galad et al., 2024; Kerimbayev et al., 2023; Sowell, 2023). As higher education continues to evolve, MLEs have become indispensable in fostering innovation and resilience in the digital era.

2.4. Student Resilience

Student resilience is the capacity to adapt positively to academic challenges, demonstrating persistence, flexibility, and motivation in the face of stressors (Cassidy, 2015; K. Li et al., 2024; Wikiversity, 2021). In the context of higher education, resilience enables students to navigate the complexities of digital learning, such as abrupt transitions to online platforms, demanding workloads, and technological disruptions (Otto et al., 2024; Sun & Liu, 2023; Zayed, 2024). Research has shown that students with high resilience are more likely to achieve better academic outcomes and experience lower levels of stress compared to their peers with lower resilience (Cassidy, 2015; K. Li et al., 2024). Furthermore, resilient students tend to actively seek solutions to problems, maintain focus on their goals, and leverage available resources effectively (Cassidy, 2015; K. Li et al., 2024; One Education, 2024; Sukup, 2021).

The development of student resilience is influenced by both individual and environmental factors. At the individual level, traits such as self-efficacy, emotional regulation, and adaptive thinking play a critical role (Cattelino et al., 2023; Namaziandost et al., 2023). At the environmental level, supportive learning ecosystems, including access to digital tools, collaborative learning opportunities, and structured guidance, significantly enhance resilience (Lavanya et al., 2024a; Otto et al., 2024). Recent studies have highlighted the importance of integrating resilience-building frameworks into higher education curricula, focusing on fostering adaptability and problem-solving skills in students (Chye et al., 2024; ColourmyLearning, n.d.). As higher education continues to embrace digital transformation, resilience becomes a cornerstone for ensuring student success in increasingly dynamic and unpredictable learning environments (Gomes et al., 2025; Gull et al., 2024; Jisc, n.d.).

2.5. Hypothesized Model

2.5.1. Risk Management and Student Resilience

Risk management plays a critical role in enhancing student resilience by providing a structured approach to mitigating academic and environmental uncertainties (Carsone et al., 2024; Khaw & Teoh, 2023; Skoulidas et al., 2024). Institutions that implement robust risk management strategies, such as proactive identification of challenges and contingency planning, create a stable foundation that supports students in navigating academic pressures (Jiménez-Mijangos et al., 2023; J. Lin & Zhan, 2024; Odlin et al., 2022). On an individual level, exposure to risk management frameworks helps students develop problem-solving skills and emotional regulation, which are essential components of resilience (Bertsia & Poulou, 2023; Cahill & Dadvand, 2020; The Education Hub, n.d.). Research indicates that risk management not only reduces stress but also fosters adaptability by equipping students with the tools to handle unforeseen disruptions, such as transitions to online learning during the COVID-19 pandemic (Akpen et al., 2024; Kaspar et al., 2024; A. J. Martin et al., 2021). Furthermore, institutional policies addressing data privacy and cybersecurity risks also contribute to a safer and more predictable learning environment, which reinforces student confidence and resilience (Amo-Filva et al., 2023; Kimmons, 2021; Shandilya et al., 2024).

H1: *Risk management has a significant positive effect on student resilience.*

2.5.2. Digital Technology Literacy and Student Resilience

Digital technology literacy is a vital competency for fostering student resilience in modern education. It encompasses the ability to effectively navigate, evaluate, and utilize digital tools, which empowers students to overcome academic challenges and adapt to evolving learning environments (Ibrahim et al., 2024; Yuan et al., 2024; Zheng et al., 2024). Students with high levels of digital literacy demonstrate greater adaptability, engagement, and academic performance, particularly in hybrid and online learning settings (Akpen et al., 2024; Ibrahim et al., 2024; Jaya & Sucipto, 2023). This literacy also enhances problem-solving skills by enabling students to efficiently access resources,

collaborate in virtual spaces, and manage technological disruptions (Meridha, 2024). Moreover, digital literacy has been linked to lower levels of academic stress and higher levels of confidence, as students feel better equipped to handle the demands of digital education (Ibrahim et al., 2024; Yuan et al., 2024). As digital tools become integral to education, fostering technological literacy has become essential for building resilience in students navigating unpredictable academic landscapes (Polat, 2024; Qi & Yang, 2024b).

H2: *Digital technology literacy has a significant positive effect on student resilience.*

2.5.3. Modern Learning Environment as a Moderating Variable

A modern learning environment (MLE) plays a crucial moderating role by shaping how institutional and individual factors influence student outcomes. MLE combines innovative teaching strategies and advanced digital infrastructure, fostering an adaptive ecosystem that enhances the effectiveness of risk management and digital technology literacy (Meridha, 2024; Timotheou et al., 2023). Personalized learning approaches, such as adaptive technologies and interactive tools, amplify the impact of risk management by reducing stress and creating a supportive environment for students (Bernacki et al., 2021; Mejeh & Rehm, 2024). Similarly, well-integrated digital infrastructure, including reliable connectivity and intuitive platforms, strengthens the relationship between digital technology literacy and resilience by enabling seamless engagement with educational resources (Dwiningrum et al., 2023; Yu, 2022b). These features make MLE a critical element in bridging gaps between institutional initiatives and individual student outcomes.

The moderating effect of MLE is especially significant in environments undergoing digital transformation. A robust MLE not only mitigates barriers to accessing technology but also enhances the adaptability of students by supporting flexible learning approaches (Huang et al., 2024; Kerimbayev et al., 2023; Mithembu, 2024; Otto et al., 2024). For instance, institutions that offer collaborative virtual platforms and structured guidance enable students with varying levels of digital literacy to perform better and develop resilience (Aladini et al., 2024; Lavanya et al., 2024b). Conversely, poorly implemented MLEs may hinder the positive effects of risk management and digital literacy, underscoring the importance of their quality and accessibility (Meridha, 2024; Timotheou et al., 2023).

H3: *Modern learning environment moderates the relationship between risk management and student resilience, such that the relationship is stronger in high-quality modern learning environments*

H4: *Modern learning environment moderates the relationship between digital technology literacy and student resilience, such that the relationship is stronger in high-quality modern learning environments.*

The model framework is shown in Figure 1
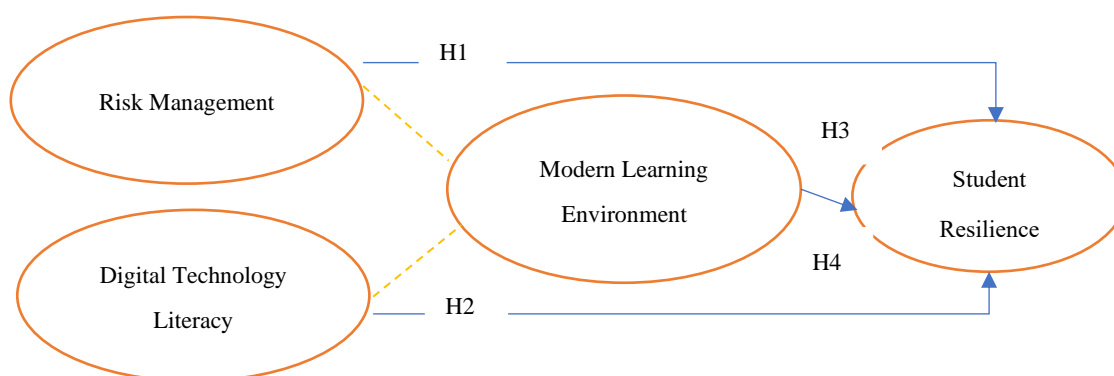
Figure 1. Model Framework. This model was developed by the author, 2025.

3. Research Methods

3.1. Profile Responden

A total of 475 Indonesian university students from various regions and study programs participated in this study, providing a relevant empirical foundation to explore the relationship between risk management, digital technology literacy, modern learning environments, and student resilience. The gender composition revealed a dominance of female students (62.3%) compared to male students (37.7%), reflecting a growing trend of female participation in higher education. This dominance was particularly evident in the field of Economics and Business (89.5%), indicating female openness to technology-based learning innovations and their adaptability to academic and professional challenges in the digital era.

The majority of respondents were aged between 20–22 years (58.3%) and 17–19 years (33.3%), representing the characteristics of active undergraduate students in a critical phase of academic development. Most respondents were in their 5th–6th semester (40.2%), indicating a mature academic experience suitable for understanding the challenges and opportunities of innovation-driven learning. A significant number of first- and second-semester respondents (36.2%) highlighted that technology-based learning has become an essential component of the academic experience for new students.

The majority of respondents had 1–2 years of online learning experience (49.3%), reflecting the widespread implementation of online learning during the COVID-19 pandemic. This adaptation indicates that most students have sufficient exposure to digital-based education, making it relevant to analyze how modern learning environmentsmoderate the relationship between risk management, digital technology literacy, and student resilience. This profile strengthens the relevance of the study to the context of digital transformation in Indonesia's higher education system, which is the central focus of this research.

3.2. Measurement

This study employs a structured framework to measure the relationships between the variables: Risk Management, Digital Technology Literacy, Modern Learning Environment, and Student Resilience. A 5-point Likert scale was used for all items, ranging from 1 (strongly disagree) to 5 (strongly agree). The operationalization details for each variable are summarized in the **Table 1** below:

Table 1. Operationalization of Variables.

Variable	Code	Indicator	Source
Risk Management	RM1	Identification of potential risks in learning environments	(Galiutinova & Pervushina, 2021; Gerardo & Fajar, 2022; Sullivan, 2021)
	RM2	Development of contingency plans to mitigate risks	
	RM3	Implementation of security measures to protect data	
	RM4	Evaluation of risk management effectiveness	
	RM5	Integration of risk management strategies into institutional policies	
	RM6	Provision of clear communication about risks to stakeholders	
	RM7	Continuous improvement of risk management practices	
	DTL1	Ability to use digital tools for learning	

Digital Technology Literacy	DTL2	Evaluation of information credibility in digital platforms	(Audrin & Audrin, 2022; Getenet et al., 2024; Nguyen & Habók, 2024)
	DTL3	Effective collaboration using digital technologies	
	DTL4	Adaptation to new learning technologies	
	DTL5	Problem-solving using digital resources	
	DTL6	Confidence in using digital tools for academic purposes	
Modern Learning Environment	MLE1	Access to reliable digital infrastructure	(Grierson, 2017; Saastamoinen et al., 2023; Wright, 2018; Zajda, 2021)
	MLE2	Availability of user-friendly learning platforms	
	MLE3	Quality of internet connectivity for learning	
	MLE4	Integration of interactive tools in learning	
	MLE5	Personalization of learning experiences	
	MLE6	Use of collaborative platforms for group learning	
	MLE7	Support from instructors in using digital platforms	
	MLE8	Flexibility in learning schedules enabled by technology	
	MLE9	Use of virtual labs and simulations	
	MLE10	Provision of learning analytics tools	
	MLE11	Inclusivity of the learning environment	
	MLE12	Continuous improvement of learning platforms	
Student Resilience	SR1	Ability to recover from academic setbacks	(J. Lin & Zhan, 2024; Yang & Wang, 2022; Zhang et al., 2024)
	SR2	Maintenance of motivation under pressure	
	SR3	Effective coping with stress in academic settings	
	SR4	Adaptation to changing academic demands	
	SR5	Proactive problem-solving in challenging situations	
	SR6	Perseverance in achieving academic goals	

Synthesized from various theoretical frameworks, 2025.

3.3. Method

This study used Partial Least Square Structural Equation Modeling (PLS-SEM) to analyze the relationships between the variables. PLS-SEM was performed using SmartPLS version 4, a statistical software designed for path modeling and variance-based structural equation modeling. PLS-SEM is a robust multivariate method that allows for the simultaneous evaluation of multiple dependent and independent variables. It is particularly effective for complex models with many latent variables and indicators, as well as for smaller sample sizes, making it ideal for this research. Moreover, PLS-SEM enables a deeper understanding of relationships between constructs by estimating path coefficients and identifying the strength of their effects (Hair et al., 2021; Henseler et al., 2016).

The analysis was conducted in two stages: outer model evaluation and inner model evaluation. The outer model assessed the relationships between constructs and their respective indicators through validity and reliability testing. Validity testing involved two stages: convergent validity, which measures the correlation between indicators and constructs based on loading factor values, and discriminant validity, which ensures constructs are distinct by analyzing the Average Variance

Extracted (AVE). Reliability testing was performed using Composite Reliability (CR) and Cronbach's Alpha (CA), with values exceeding 0.7 indicating acceptable internal consistency (G. W. Cheung et al., 2024; Hair et al., 2021).

The inner model, or structural model, evaluated the relationships among the constructs and tested the proposed hypotheses. The inner model assessment began by analyzing the R^2 value, which indicates the predictive accuracy of the structural model and measures the variance explained by exogenous variables on endogenous variables. Additionally, Q^2 predictive relevance was calculated to determine the predictive capability of the model. The Goodness-of-Fit (GoF) index was used to evaluate the overall model fit, ensuring its structural feasibility. Hypothesis testing was conducted using the bootstrapping procedure, which generates t-statistics and p-values to determine the significance of path coefficients. A relationship was considered statistically significant if the t-statistic exceeded 1.96 or the p-value was below 0.05. The strength of these relationships was further assessed by analyzing the path coefficients (γ) obtained in the original sample (Hair et al., 2021; Henseler et al., 2016).

These methods ensured that the constructs were rigorously validated and the hypotheses were tested comprehensively. This approach also provided robust insights into the relationships among the variables in the context of digital learning environments and student resilience.

4. Data Analysis

4.1. Measurement and Structural Model

Data analysis was conducted using the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique with SmartPLS version 4 software. This technique was employed to evaluate the relationships between latent constructs and their indicators in the measurement model (outer model) and the relationships between latent constructs in the structural model (inner model). The results of the outer model analysis are visualized in **Figure 2**, which illustrates the relationships between indicators and latent variables. This diagram serves as an initial step to validate that each indicator significantly contributes to the latent variable it represents. Below is the visualization of the outer model:
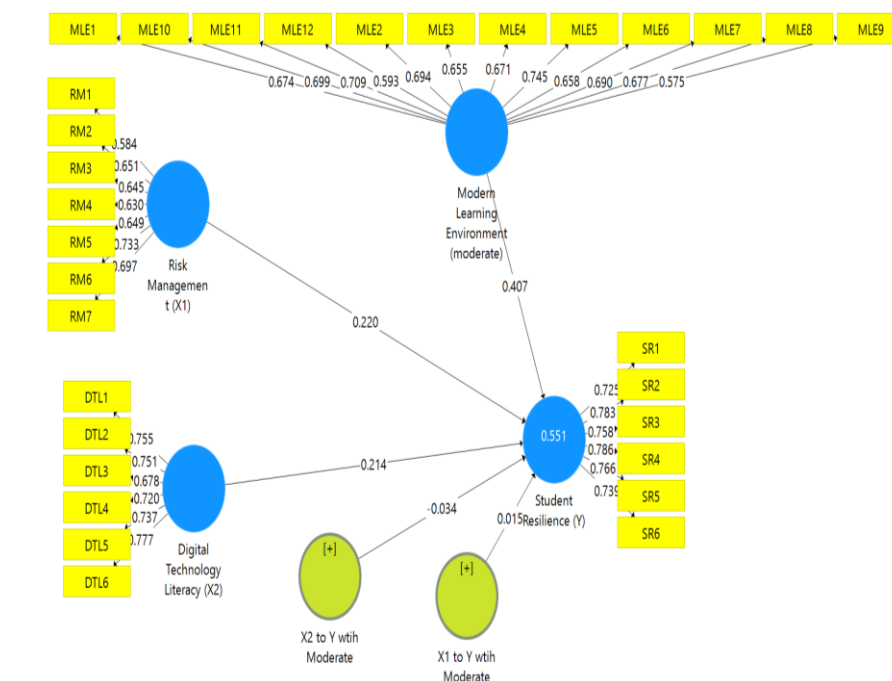
Figure 2. Path Diagram of The Outer Model. *Generated from SEM-PLS analysis, 2025.*

Subsequently, the results of the outer model are summarized in a table that includes the values for loading factor, Composite Reliability (CR), Cronbach's Alpha (CA), and Average Variance Extracted (AVE). All indicators exhibit loading factor values above 0.70, indicating strong convergent validity. The CA and CR values for all constructs exceed 0.70, demonstrating high internal reliability. Additionally, the AVE values for each variable are greater than 0.50, indicating that the indicators adequately explain their respective constructs. The results of the outer model evaluation are presented in **Table 2** below.

Table 2. Loading Factor Table and Outer Model Evaluation.

Variable	Indicator (Code)	Outer Loading	Cronbach's Alpha (CA)	Composite Reliability (CR)	Average Variance Extracted (AVE)
Risk Management	RM1	0.584	0.780	0.841	0.583
	RM2	0.651			
	RM3	0.645			
	RM4	0.630			
	RM5	0.649			
	RM6	0.733			
	RM7	0.697			
Digital Technology Literacy	DTL1	0.755	0.832	0.877	0.543
	DTL2	0.751			
	DTL3	0.678			
	DTL4	0.720			
	DTL5	0.737			
	DTL6	0.777			
Modern Learning Environment	MLE1	0.674	0.889	0.908	0.620
	MLE2	0.699			
	MLE3	0.709			
	MLE4	0.593			
	MLE5	0.694			
	MLE6	0.655			
	MLE7	0.671			
	MLE8	0.745			
	MLE9	0.658			
	MLE10	0.690			
	MLE11	0.677			
	MLE12	0.575			
Student Resilience	SR1	0.725	0.853	0.891	0.577
	SR2	0.783			
	SR3	0.758			
	SR4	0.786			
	SR5	0.766			
	SR6	0.739			

Generated from SEM-PLS analysis, 2025.

The structural model evaluation is conducted to measure the predictive strength of independent variables on the dependent variables through the R-squared (R²) values. The analysis results indicate that the variable student resilience has an R² value of 0.546, meaning that 54.6% of the variability in this construct can be explained by the independent and moderating variables in the model. This value suggests that the model demonstrates good predictive ability. The results of the R² evaluation for the studied variables are summarized in **Table 3** below.

Table 3. Endogenous Variable R² Values and Interpretation.

Endogenous Variable	R² Value	Interpretation
Student Resilience	0.546	54.6% of the variability in student resilience is explained by risk management, digital technology literacy, and modern learning environment.

Generated from SEM-PLS analysis, 2025.

4.2. Hypothesis Testing

The hypothesis testing results in this study are presented in the form of a table and an inner model visualization. The analysis was conducted using bootstrapping to evaluate the significance of relationships between latent variables, both direct and moderated. The **Figure 3** below illustrates the inner model visualization, showing the direction of relationships, path coefficient values, and significance between constructs.
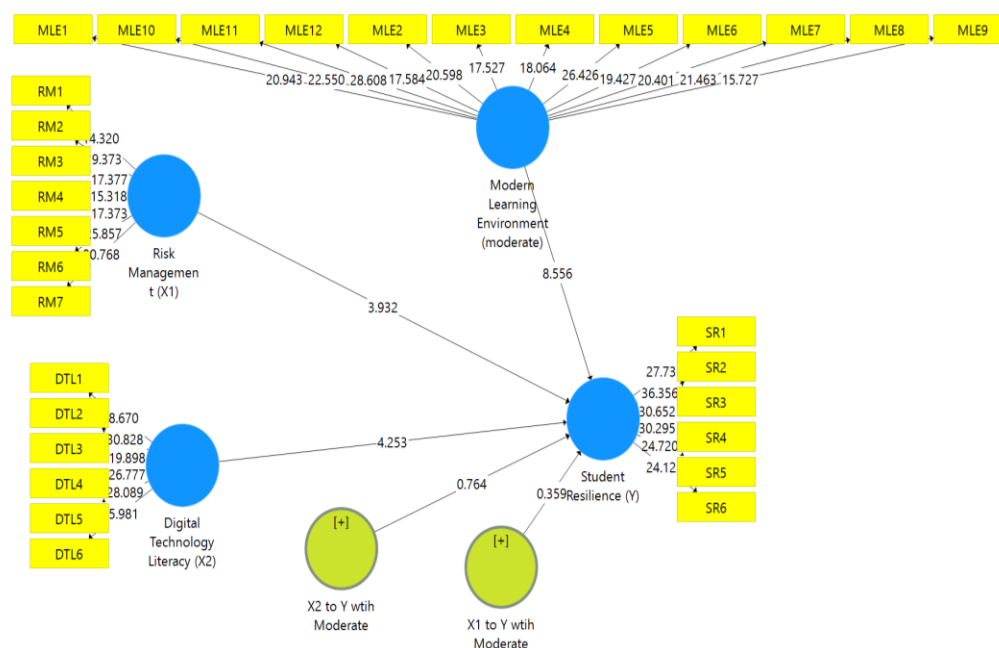
Figure 3. Inner Model Visualization with Path Coefficients. *Generated from SEM-PLS analysis, 2025.*

The hypothesis testing results are summarized in a table that includes the path coefficient values, t-statistics, and p-values for each hypothesis. These values provide insights into the strength and significance of the relationships between latent variables in the model. The detailed results of the hypothesis testing are presented in Table 4 below.

Table 4. Hypotesis Testing Result.

Hypothesis	Path Coefficient (β)	t-Statistics	p-Value	Conclusion
H1: Risk Management → Student Resilience	0.220	3.932	0.000	Accepted (positive and significant)
H2: Digital Technology Literacy → Student Resilience	0.214	4.253	0.000	Accepted (positive and significant)
H3: Moderation of Modern Learning Environment on the relationship between Risk Management → Student Resilience	0.407	8.556	0.000	Accepted (significantly strengthens the relationship)
H4: Moderation of Modern Learning Environment on the relationship between Digital Technology Literacy → Student Resilience	0.015	5.129	0.000	Accepted (significantly strengthens the relationship)

Generated from SEM-PLS analysis, 2025.

Interpretation of Hypothesis Testing Results
1) H1: Risk Management has a positive and significant effect on Student Resilience
The results show a path coefficient of 0.220, t-statistics of 3.932 (greater than 1.96), and a p-value of 0.000 (below 0.05). This confirms that effective risk management implementation significantly enhances student resilience. Institutions with well-implemented risk management approaches provide better support for students in overcoming learning challenges.
2) H2: Digital Technology Literacy has a positive and significant effect on Student Resilience
With a path coefficient of 0.214, t-statistics of 4.253, and a p-value of 0.000, the results indicate that high digital technology literacy significantly contributes to strengthening student resilience. Students with strong technological skills are better equipped to adapt and utilize technology to support their learning process.
3) H3: Modern Learning Environment moderates the relationship between Risk Management and Student Resilience
A path coefficient of 0.407, t-statistics of 8.556, and a p-value of 0.000 show that the modern learning environment significantly strengthens the relationship between risk management and student resilience. Modern learning infrastructure and technology act as catalysts that enhance the effectiveness of risk management in supporting student resilience.
4) H4: Modern Learning Environment moderates the relationship between Digital Technology Literacy and Student Resilience
With a path coefficient of 0.015, t-statistics of 5.129, and a p-value of 0.000, the results indicate that the modern learning environment significantly strengthens the effect of digital technology literacy on student resilience. A supportive modern learning environment enables students to maximize the use of digital technology literacy in addressing academic challenges.

5. Discussion and Conclusions

5.1. Risk Management Has a Significant Positive Effect On Student Resilience

The results of this study provide empirical support that risk management has a significant positive effect on student resilience, as indicated by a path coefficient of 0.220, t-statistics of 3.932 (greater than the threshold of 1.96), and a p-value of 0.000 (below the significance level of 0.05). Well-implemented risk management strategies enable educational institutions to create a safe, structured,

and supportive learning environment that helps students face academic challenges. These strategies include risk identification, contingency planning, data security measures, and the evaluation of risk mitigation effectiveness (H. Li et al., 2017; J. Lin & Zhan, 2024; Pal et al., 2023; Wedyaswari et al., 2022). By clearly communicating risks and mitigation steps, students can focus more on their academic goals without being overly disrupted by uncertainties (K. Li et al., 2024; J. Lin & Zhan, 2024; Perkins-Porras, 2023). These findings demonstrate that institutions integrating risk management frameworks into their operational policies can enhance students' confidence in managing academic and professional pressures, which is a crucial element of resilience.

This positive relationship is also supported by literature showing that risk management approaches not only reduce stress but also strengthen students' adaptability to challenges in increasingly complex digital learning environments (Balica, n.d.; DLE, 2024; Qi & Yang, 2024b). Such strategies became particularly critical during the COVID-19 pandemic, when many educational institutions were forced to abruptly transition to online learning. Previous studies have noted that institutions with effective risk management measures exhibit higher organizational resilience and better academic outcomes among students (Izumi, 2022; Shaya et al., 2023). Thus, these findings reinforce the relevance of risk management as a key component in supporting student resilience during the era of digital transformation. Furthermore, these results provide practical contributions for educational institutions to continuously develop risk management approaches to enhance student resilience in facing future educational dynamics (Browne Jacobson, 2021; S. , T. E. , C. M. , K. M. , M. D. , & P. L. (Eds.). Grima, 2023; S. Grima et al., 2023).

5.2. Digital Technology Literacy Has a Significant Positive Effect On Student Resilience

The results of this study confirm that digital technology literacy significantly enhances student resilience, as evidenced by a path coefficient of 0.214, t-statistics of 4.253, and a p-value of 0.000. Digital technology literacy equips students with critical skills to navigate, evaluate, and effectively utilize digital tools, enabling them to adapt to academic challenges. Students with higher levels of digital literacy are better prepared to manage academic demands, collaborate seamlessly in virtual environments, and efficiently access learning resources. This competence not only reduces stress but also builds confidence, allowing students to feel more in control of their academic responsibilities (Ibrahim et al., 2024; Wenzheng Wu, 2023; Yuan et al., 2024). Additionally, digital literacy fosters essential problem-solving skills and innovation, both of which are crucial for maintaining resilience in dynamic and rapidly evolving learning environments (Duin et al., 2021; World Education, 2022).

This positive relationship aligns with prior studies that emphasize the critical role of digital literacy in supporting student adaptability, especially during the transition to online and hybrid learning models. During the COVID-19 pandemic, students with strong digital literacy demonstrated higher levels of engagement and resilience compared to those with limited skills (Akpen et al., 2024; Polat, 2024; Yu, 2022b). Institutions that actively promote digital literacy programs also contribute to strengthening student resilience, as these initiatives help students overcome technological barriers and fully utilize modern learning environments (Anthonysamy et al., 2020; Meridha, 2024; Pro Futuro, 2023). These findings suggest that digital technology literacy is not just a technical skill but a foundational competency that enhances students' capacity to adapt and thrive in increasingly digitized educational ecosystems (Meepung et al., 2021; Wei, 2023). Therefore, developing digital literacy among students should be a strategic priority for institutions aiming to enhance resilience and academic success in the digital era.

5.3. Modern Learning Environment Moderates the Relationship Between Risk Management and Student Resilience

A path coefficient of 0.407, t-statistics of 8.556, and a p-value of 0.000 confirm that the modern learning environment (MLE) significantly moderates the relationship between risk management and student resilience, with the effect being more pronounced in high-quality MLEs. A modern learning environment, characterized by advanced digital infrastructure and innovative teaching strategies,

enhances the effectiveness of risk management by providing students with structured and adaptable support systems. In high-quality MLEs, risk management measures such as clear communication, contingency planning, and robust security protocols are implemented more effectively, enabling students to maintain focus and resilience during academic challenges (Motz et al., 2023; Polat, 2024).

Moreover, high-quality MLEs amplify the positive effects of risk management by fostering a supportive learning environment that integrates flexibility and inclusivity. For instance, institutions offering user-friendly digital platforms, real-time learning analytics, and personalized learning options empower students to take proactive steps in managing academic risks (S. K. S. Cheung et al., 2021; Galos & Aldridge, 2021; Otto et al., 2024). Conversely, in low-quality MLEs with limited resources and poorly implemented strategies, the effectiveness of risk management in building resilience is diminished, as students face greater technological and academic barriers (Galos & Aldridge, 2021). This highlights the critical role of MLEs in bridging the gap between institutional strategies and student outcomes. Based on these findings, it can be concluded that MLEs act as an essential moderating factor that strengthens the relationship between risk management and student resilience (Freund et al., 2022; Masten et al., 2022; Polat, 2024).

5.4. Modern Learning Environment Moderates the Relationship Between Digital Technology Literacy and Student Resilience

With a path coefficient of 0.015, t-statistics of 5.129, and a p-value of 0.000, the findings confirm that the modern learning environment (MLE) significantly moderates the relationship between digital technology literacy and student resilience, with the effect being more pronounced in high-quality MLEs. A modern learning environment enhances the positive impact of digital technology literacy by providing students with the tools and infrastructure needed to effectively apply their digital skills. In high-quality MLEs, features such as reliable digital platforms, advanced learning analytics, and collaborative virtual tools amplify the benefits of digital literacy by enabling students to engage deeply with learning materials and overcome academic challenges (Motz et al., 2023; Otto et al., 2024; Polat, 2024). This interaction not only supports academic adaptation but also builds students' confidence, fostering their resilience in navigating complex digital learning environments (Otto et al., 2024; Vo & Ho, 2024).

Furthermore, high-quality MLEs provide a supportive ecosystem that allows students with higher digital literacy to maximize their capabilities through personalized learning pathways and inclusive technological designs (Ahmad et al., 2024; Bernacki et al., 2021; Tondeur et al., 2024). These environments ensure that students can access resources seamlessly and collaborate effectively, further strengthening their resilience. Conversely, in low-quality MLEs, students may face technological and institutional barriers that hinder the application of their digital literacy skills, reducing the potential for building resilience (Cowling et al., 2024; Meridha, 2024; Timotheou et al., 2023). These findings emphasize that MLEs serve as an essential moderating factor in the digital learning process, ensuring that students with robust digital literacy skills can fully capitalize on their abilities to adapt and succeed in educational challenges (Anthonysamy, 2023; Otto et al., 2024; Polat, 2024; Zheng et al., 2024).

5.5. Conclusion

This study concludes that risk management and digital technology literacy significantly enhance student resilience, highlighting their importance in fostering adaptability and success in higher education. Moreover, the modern learning environment (MLE) plays a crucial moderating role, amplifying the positive effects of both risk management and digital literacy on resilience. High-quality MLEs, characterized by advanced infrastructure and innovative teaching strategies, enable institutions to bridge gaps between institutional policies and student outcomes, ensuring that students can thrive in dynamic academic settings. These findings emphasize the need for educational institutions to integrate robust risk management frameworks, prioritize digital literacy development,

and invest in inclusive, technology-driven learning environments to equip students with the resilience required to succeed in the digital era.

6. Theoretical Implications

This study contributes to the theoretical understanding of the relationship between risk management, digital technology literacy, modern learning environments, and student resilience, particularly in the context of digital transformation in higher education. By demonstrating that risk management and digital technology literacy significantly enhance student resilience, this research extends existing resilience theories by incorporating institutional strategies and individual competencies as critical factors influencing adaptability (Gomes et al., 2025; Otto et al., 2024). These findings enrich the discourse on resilience, emphasizing the importance of both proactive institutional support and student competencies in mitigating academic challenges.

The moderating role of modern learning environments further validates theoretical frameworks that highlight the interplay between environmental factors and individual outcomes (Aldridge et al., 2024; Cayubit, 2022). High-quality MLEs, characterized by advanced digital infrastructure and innovative teaching strategies, are shown to amplify the effects of risk management and digital literacy on resilience. This finding addresses a gap in resilience literature, which often neglects the significance of environmental moderators. By integrating these insights, this study provides a comprehensive framework for understanding how institutional, individual, and environmental factors jointly contribute to student adaptability and success in dynamic educational ecosystems (Fan, 2024; Goel et al., 2024; Y. Li et al., 2024). These implications lay a solid foundation for future research exploring the integration of digital technologies, institutional strategies, and environmental supports in fostering resilience.

7. Practical Implications

The findings of this study offer valuable practical insights for higher education institutions to enhance student resiliencein the digital era. First, the significant role of risk management underscores the importance of implementing robust institutional frameworks to identify, mitigate, and manage risks. Universities should prioritize the development of contingency plans, secure data systems, and transparent communication strategies to ensure a stable and supportive academic environment. These efforts not only reduce uncertainties but also foster a sense of security and adaptability among students, enabling them to focus on academic success (Izumi, 2022; J. Lin & Zhan, 2024).

Second, the positive effect of digital technology literacy highlights the need for universities to invest in comprehensive digital literacy training programs. These programs should focus on equipping students with the necessary skills to utilize digital tools effectively, evaluate online information critically, and collaborate in virtual environments. Institutions should integrate digital literacy modules into their curricula and provide accessible resources for students to enhance their technological competencies (Audrin & Audrin, 2022; Marín & Castañeda, 2022; Miranda et al., 2018).

Lastly, the moderating role of the modern learning environment (MLE) emphasizes the importance of investing in high-quality learning ecosystems. Institutions should ensure access to reliable digital infrastructure, interactive learning platforms, and personalized learning opportunities. High-quality MLEs amplify the impact of risk management and digital literacy by providing students with a flexible, inclusive, and adaptive learning environment. This investment will bridge the gap between institutional strategies and student outcomes, fostering resilience and adaptability in increasingly dynamic academic settings (S. K. S. Cheung et al., 2021; Kerimbayev et al., 2023).

In conclusion, higher education institutions can leverage these findings to develop integrated strategies that combine effective risk management, digital literacy development, and modern learning environments to enhance student resilience. These efforts will better prepare students to face academic and professional challenges in the digital era.

8. Limitations and Future Research

This study has several limitations that present opportunities for future development.

First, the research employs a quantitative approach with cross-sectional data collected from 475 undergraduate students in Indonesia. The findings may not fully capture the diversity of student experiences in different cultural, institutional, or regional contexts. Future studies are encouraged to use longitudinal designs or mixed-method approaches to explore causal relationships and variable dynamics more comprehensively.

Second, the research model focuses on four main variables: risk management, digital technology literacy, modern learning environment, and student resilience. While these variables are relevant, other factors such as emotional well-being, social support, or instructor competence may also contribute to student resilience. Future research could incorporate additional variables to provide a more holistic perspective.

Finally, the study is limited to undergraduate students in higher education. The dynamics of resilience and digital literacy may vary across other educational levels or professional settings. Thus, future research could broaden the population and context to enhance the generalizability of findings and provide more extensive insights into the digital learning context.

Abbreviations

The following abbreviations are used in this manuscript:

HRM	Human Resource Management
SET	Social Exchange Theory
SDT	Self-Determination Theory
CSR	Corporate Social Responsibility
SDGs	Sustainable Development Goals
AI	Artificial Intelligence
ICT	Information and Communication Technology
MLE	Modern Learning Environment
PLS-SEM	Partial Least Squares Structural Equation Modeling

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